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THE ECOLOGY OF DIPUS SAGITTA

BY B. K. FENIUK AND J. M. KAZANTZEVA

The ecology of jerboas of U. S. S. R. has been much neglected in the literature. Accordingly the authors undertook an investigation of the ecology of *Dipus sagitta innae* Ognev (1930), from April 14 to the last of June, and from the first of August to November 17, 1935. We were located at the Novo-Ushtagan antiplague station, district of Djangalinsk, West Kazakhstan (Volga-Ural sandy territories; geographical coördination in latitude about 48 degrees N. and in longitude 18 degrees 30 minutes E. from Pulkovo Observatory).

Jerboas to the number of 501 were caught and investigated, 214 burrows were excavated, and a great amount of data concerning the diet and behaviour of these mammals was accumulated. We also made use of the results of dissections of *Dipus sagitta* performed in the Novo-Ushtagan station during preceding years by the zoologists G. Rall, M. Demiashev, and M. Sheikina (541 specimens were dissected in 1932, 62 in 1933, and 31 in 1934).

Habitat.—The general environmental conditions necessary for all species of jerboas, independently of their stenotopic qualities, is the presence of patches of bare ground. A great many leaping rodents, including jerboas, are adapted to desert territories. A considerable percentage of juicy dicotyledons and bulbous plants amid desert and semidesert surroundings insures for the jerboas a food supply rich in moisture, which is otherwise unobtainable, and also allows the utilization of their equipment for rapid locomotion.

Dipus sagitta is a typical psammophil, but it avoids quite bare sands. Its habitat is formed by aeolian sands anchored by plants. In the Volga-Ural sands such an environment is afforded in the so-called big sandhills (fig. 2).

The Volga-Ural sands represent a vast region situated between the lower parts of the Volga and Ural rivers. These sands are characterized by the

combination of three landscape elements: 1/ shifting sands in different stages of overgrowth with plants; 2/ tracts of sandy steppe plain; and 3/ a great many salt marshes and salt lakes scattered between both of the foregoing types. Based upon this landscape combination, Rall (1937, pp. 150–154), characterized the Volga-Ural sands as a mosaic complex of three members.

These three sandy elements are in a state of permanent flux, comprising the processes of overgrowth and levelling of sands down to a state of hilly, grassy steppe on the one hand, and a secondary process of dispersion of overgrown sands and sandy steppe on the other. This dispersion is being accomplished rapidly, partly because of a desert climate, and partly owing to immoderate pasturage of cattle. As a result of this dispersion, there occurs an initial stage of bare sands devoid of vegetation. Such sands present a system of semilunar hillocks from 0.5 to 5.6 meters high (the so-called barkhans), which are easily transported by the wind from one place to another. In our country the typical barkhan hillocks are scattered in small islands occupying an area varying from a fraction of a hectare to several hectares (fig. 1).

A pioneer plant in the overgrowth of hillocks is *Elymus giganteus*. This grass rapidly forms considerable masses of turf, with tall leaves and stems. Characteristic hillocks from 0.5 to 2.0 meters high form around the bunches of *Elymus*. The plant ever occupies new areas. Under its cover the sands are being populated by new species of plants, such as *Aristida pennata*, *Salsola kali*, *Corispermum aralo-caspicum*, *Agriophyllum arenarium*, *Chondrilla juncea*, *Tragopogon brevirostris*, and *Eremosparton aphyllum*. The number of freely transferable hillocks of sand then begins to decrease. At last they disappear altogether, the sands become more plane, and only small plots of shifting sands remain between the hillocks covered with bunches of *Elymus*. The appearance of plants assures colonization of the big sand hillocks by rodents. In addition to *Dipus sagitta* appear gerbils (*Pallasiomys meridianus* and *Meriones tamaricinus*), house mice (*Mus musculus wagneri*), yellow ground squirrels (*Citellus fulvus*), and others.

Under the continuation of the overgrowth process the excessive looseness and permeability of the sand decreases. In the end there is suppression of such hydrophil cereals as *Elymus giganteus*, and penetration into the sandy territories of more xerophylous plants (*Artemisia arenaria*, *A. scoparia*, *A. austriaca*, *Peganum harmala*, *Agropyrum repens*, *A. sibiricum*, *Ceratocarpus arenarius*), and among them some spring ephemerea (as *Alyssum minimum* and *Poa bulbosa vivipara*). The typical psammophytes disappear, the sands change first into small sandy hillocks (fig. 3), and then into grassy sand steppe. The serried vegetation and the absence of shifting sands do not allow *Dipus sagitta* to reside among small sand hillocks. Their burrows may be found

but seldom in sandy hollows excavated by the wind, and in the confines of big hillocks. In a plain steppe *D. sagitta* does not live at all.

The climate of the Volga-Ural sands is pronouncedly continental. The summer temperature maximum in the neighbourhood of Novo-Ushtagan in 1935 was 53 degrees Centigrade (under the shade of a thin bush). In summer there prevail dry east and southeast winds from the arid deserts of Middle Asia. Precipitation is lower than 200 mm. per year, chiefly in the summer months. The ecologic climatic conditions of life for the majority of animals are very hard, but jerboas can live under the conditions of a relatively favorable micro-climate, owing to their nocturnal and fossorial habits of life.

Populations.—The methods of the quantitative population samplings of jerboas have been unsatisfactory in the past. We employed a rather difficult, but sufficiently precise, method, checked by subsequently excavating the burrows on areas of 0.5 hectares. The jerboas are difficult to trap. In sand all traces of animal activity are printed with exhaustive completeness, and in such surroundings occupied burrows are found with ease, in spite of the plugs of sand at the entrances.

The search for burrows must be made early in the morning, for the daily winds in summer, which begin to blow at 7 to 9 A.M. rapidly erase all trace of the animals and their holes, and reëstablish the ripple marks characteristic of aeolian sands.

As is shown in table I, the density of population in colonies of *Dipus sagitta* is not great. The highest figure obtained is 11 inhabited burrows and 21 animals for 1 hectare. A certain degree of colonizing is apparent. Two contiguous half-hectares may have different population densities (areas no. 1–2, 3–4, 7–8, 15–16).

Burrows.—In the literature on the subject there are few successful classifications of the kinds of burrows made by *Dipus sagitta.* Thus, Smirnov and Gugenotova (1928, pp. 437 and 497), who had been working also in Novo-Ushtagan, recognized three general types of burrows. Two of them, characterized by the plugging of the burrow entrance during the day, they considered to be burrows of males, and a third type, distinguished by the presence near the entrance of a small heap of sand freshly ejected, to belong to females. This assumption is erroneous, for a small heap of sand near the entrance of a hole means only that the animal has recently been working at the hole. The plugging of holes with sand is an act performed by the great majority of jerboas during summer. Neither the one nor the other depends on the sex or on the age of the animal. Boehme and Krasovskij (1930, pp. 422–424) divide the burrows of *D. sagitta nogai* into 3 types. Those of the first type are not deep, "they usually do not contain any nest; it is evident that in the last case such a burrow is to be changed for a new one". The burrows of the second type are deeper than the former; they are always provided with a nest chamber and serve for rearing the young.

A great similarity between the burrows described by the authors cited above and those that we have studied ourselves, allows us to reject this classification also. In our estimation, all of them are of the same type, the differences being due to the ages of the burrows.

We consider that there are three types of burrows of *Dipus sagitta:* permanent summer burrows, where the jerboas pass the whole period of their active lives, bearing and rearing the young; temporary summer burrows, which are utilized by the animals during their nocturnal excursions; and winter burrows, where the animals pass the period of hibernation.

Permanent summer burrows.—After having fixed upon a suitable place, the jerboa begins to dig the entrance passage of a burrow, deepening it at an angle of 10 to 45 degrees. When as much as 40, 60, or 100 cm. has been dug, the animal proceeds to the construction of other parts of the burrow;

TABLE 1

DENSITY OF OCCURRENCE OF DIPUS SAGITTA

DATES	DENSITY PER 0.5 HECTARE		DENSITY PER 1. HECTARE		DATES	DENSITY PER 0.5 HECTARE		DENSITY PER 1. HECTARE	
	Burrows	Animals	Burrows	Animals		Burrows	Animals	Burrows	Animals
June 7	3	3	3	3	Aug. 23	4	6	11	21
June 7	0	0			Aug. 28	7	15		
June 11	2	2	2	2	Sept. 8	1	1	2	2
June 11	0	0			Sept. 8	1	1		
June 17	6	6	6	6	Sept. 8	2	2	4	4
June 21	3	3	3	3	Sept. 14	7	17	7	17
July 20	5	9	5	9	Sept. 14	0	0		
July 20	0	0			Oct. 4	4	4	8	8
July 25	3	6	6	12					

The density per hectare is calculated by adding the figures for contiguous half-hectares.

a nest chamber, or an additional entrance. As a rule, the jerboa abandons the initial passage and fills it with sand. In order to prepare a new entrance, the animal digs a new passage from within the burrow. After returning to the burrow for the day, the jerboa plugs the entrance with sand. The natives of the southeastern region of R. S. F. S. R. have given to these plugs the apt name of "navel" ("pupotchek", from the word "pupok" = navel). In this manner the burrow of the jerboa is protected during the day from enemies and from the high temperature of the air.

In spring and summer, *Dipus sagitta* usually constructs the nest chamber at the end of a short lateral passage of the burrow; and in autumn, in a deeper part of the burrow. In the burrows provided with upper nests, a passage is dug below the nest. It may be supposed that the animal remains there during the hottest hours of the day. The jerboa often uses this passage

while trying to escape an enemy that has gained entrance to a burrow. In such cases the animal endeavors to bury itself in the sand at the end of the deepened passage. After having left the burrow, the jerboa stops the entrance with a sand plug.

In addition to the main exit, *Dipus sagitta* begins from within the burrow one and sometimes several emergency exits, which it does not complete. Construction stops short of the surface by a distance of 10 to 15 cm. Through such an emergency exit the animal may burst from the burrow in case of danger.

As material for construction of nests, *Dipus sagitta* employs the dry, slightly decayed parts of *Elymus giganteus* situated near the roots; rarely also stalks and leaves of *Aristida pennata*. In the burrow the animal holds a wisp of grass in its mouth and tears it into shreds with rapid kicks of its feet (observed in a warren).

Summarizing the arrangement of permanent summer burrows, one may note the presence of following features; (a) an initial passage through which the burrow is being built. As a rule, this passage is not utilized further and is filled with sand. In excavating a burrow one frequently overlooks this passage. (b) A passage of permanent use stopped up in the day time with a short sand plug (a "navel"). (c) Emergency exits. (d) Nest chamber. (e) A deepened passage.

The permanent summer burrows vary considerably in regard to their arrangment. They can be primitively simple. We excavated 14 such burrows with a length from 1 to 0.5 meters; 11 of them were occupied by females, 6 of which had young. But this kind of burrow is not to be considered as the family type of burrow, for we also took solitary males from them, and we found females with young in different sorts of burrows, even without nest chambers. On the other hand, one sometimes encounters burrows with a striking complexity of arrangement, perhaps with several nest chambers. The length of the emergency exit may attain 3 to 4 meters. The burrows of females are slightly more complicated than those of males and of young. In the former the length of the passage is 480 and in the latter, 319 mm.

Before proceeding to the description of other types of burrows of *Dipus sagitta*, we deem it necessary to dwell upon the character of the entrance orifice of permanent summer burrows.

A small heap of earth ejected by a jerboa in digging a burrow is very typical. It is mostly a narrow, long (1.5 to 2 meters) cylinder of sand 10 to 15 cm. high, on all sides of which are strewn, in the form of a fan, "splashes" of sand (fig. 4). The sand does not remain in that form for long, for the next gust of the wind obliterates it completely. Sometimes the animal itself levels the sand it has ejected, leaving in its place only a broad trodden

area of 2 to 3 meters, which is easy to distinguish because of a distinctive hue in the color of the sand.

The sand plug protruding from the permanent passage is similar, when the sand is damp, to the analogous plugs in the burrows of other species of jerboas. During a long drought the surface of the sand becomes so dry (a layer 15 to 25 cm. thick) that the entrance orifice of the burrow crumbles, and before entering the burrow, the animal must throw out the sand until there has been formed a large funnel-shaped cavity at the entrance (fig. 5). Such a funnel gives but little idea of a burrow orifice, so that only the presence of prints of feet and tail indicate an occupied burrow.

The emergency exits can be detected only by probing the sand with the fingers.

In the autumn and early spring *Dipus sagitta* keeps the orifices of the burrows open during the day.

The temporary summer burrow is very simple, and resembles that of *Allactaga jaculus* (Feniuk, 1929, p. 8). It is a short, generally unbranched tunnel, sometimes at the foot of a small hillock or near a tuft of plants.

The wintering burrows can be characterized as follows: A depth considerably greater than that of summer burrows, with the nest chamber always situated at the end of the burrow. The depth of the nest in 15 wintering burrows varied from 80 to 190 cm. All these data are given below:

	DEPTH OF THE NEST FROM THE SURFACE					
	80–90	91–100	101–125	125–150	190	Total
Number of cases.....	1	2	4	7	1	15

The construction of a wintering burrow takes several days, during which time the jerboa continues to live in its summer burrow. The sand ejected from the hole is smoothed by the animal during the same or on the following night. Leaving the burrow after work, the jerboa carefully plugs the orifice of the hole with sand and tramples it down. As the animal turns its back to the burrow during this action, there is formed over the entrance a very characteristic "rosette" of the animal's traces (fig. 6).

Finally, one may note the existence of two periods of strenuous digging activity among the hairy-footed jerboas. As can be seen in table 2, the number of newly constructed holes, among 214 burrows of *Dipus sagitta* excavated by us in 1935, was maximal in April (vernal constructive period of summer burrows) and in October (construction of winter burrows). We shall return to the examination of other data of table 2.

Food habits.—Dipus sagitta is chiefly vegetarian in food habits, but, as in other species of jerboas, a certain proportion of its ration consists of insects.

As vegetable food it prefers seeds, but the deficiency of moisture in this kind of food and the lack of free water in its habitat obliges it to seek succulent green parts of plants for supplying its moisture needs.

The season of active life of *D. sagitta* may be divided, in regard to food conditions, into three periods; spring, summer, and fall.

The spring period lasts from the awakening of jerboas from hibernation until the middle of June. The principal food during this period is last year's seeds of *Agriophyllum arenarium* and *Salsola kali*, collected by the animals from plants of the previous year, now partly covered with sand. Among other plants readily eaten in this period are *Mulgedium tataricum*, *Chondrilla juncea* and *Artemisia arenaria*.

The summer period (from the middle of June to the end of August). The seeds of *Elymus giganteus* begin to ripen in June, and the jerboas proceed to feed upon them. At first the animals are attracted by the ears accidentally scattered on the sand by cattle, but soon they begin themselves to cut the

TABLE 2

THE TYPES OF BURROW ENTRANCES OF DIPUS SAGITTA ACCORDING TO SEASON

MONTHS	NUMBER OF CASES IN PER CENT			TOTAL NO. BURROWS EXCAVATED
	Fresh heap of sand	Plugs and funnels	Open entrances	
April	58.8	5.9	35.3	17
May	36.4	59.1	4.5	22
June	29.1	58.3	12.5	24
Aug.	27.4	70.6	2.0	51
Sept.	36.6	43.4	20.0	30
Oct.	48.0	9.8	42.2	57
Nov.	0	7.7	92.3	13

stalks of *Elymus*. Ripening of the seeds of this plant ends in August, they then fall to the ground, and the wind carries them to the leeward slopes of the small sand hillocks. It is here that they are found by the jerboas, which loosen the sand in searching for the scattered seeds. Supplementary species of food plants are listed in table 3.

The fall period (from the beginning of September until the jerboas enter hibernation). In the first days of September, *Agriophyllum* and *Salsola* begin to ripen, the supply of seeds of *Elymus* decreases, and the jerboas begin again to feed on seeds of the former two species of plants.

The list of food plants of *Dipus sagitta* contains 23 species. It would be considerably increased if the observations had been made over a larger territory. It is essential to note, however, that the leading food plants—that is to say the ordinary plants of big sand hillocks—are the first 6 species of table 3.

Dipus sagitta uses chiefly the sense of smell in searching for food. They

unerringly find gall nuts on the basal parts of *Salsola kali* and *Agriophyllum arenarium*, situated underground, dig them up and extract the succulent grubs of weevils. They search persistently for subsurface sprouts of *Mulgedium tataricum*, digging for the purpose small pits about 10 cm. deep. The choice of food attests to a certain originality in the sense of palatability in the jerboas. At different seasons they eat different, sometimes quite insignificant, parts of the same plant. They are especially fond of plants

TABLE 3

LIST OF FOOD PLANTS OF DIPUS SAGITTA

PLANTS	PARTS EATEN IN		
	Spring	Summer	Fall
Salsola kali	Last year seeds; yng. growth	Yng. growth; yng. plants	Seeds
Agriophyllum arenarium	"	"	"
Elymus giganteus	Veg. parts	Seeds	—
Mulgedium tataricum	"	Veg. parts	—
Chondrilla juncea	"	Flowers; fruit	Fruit
Artemisia arenaria	"	Flower buds	Flowers; fruit
Corispermum intermedium	Yng. growth	Yng. growth; yng. plants	Fruit
Sirenia sessiliflora	Ovaries	Seeds	—
Peganum Harmala	Ovaries; flowers	Fruit	Veg. parts
Alyssum minimum	Fruit	—	—
Bromus tectorum	"	—	—
Astragallus virgatus	Ovaries; buds	—	—
Eremosparton aphyllum	Underground stems	—	—
Tragopogon brevirostris	—	Leaves	—
Nitraria Schoberi	—	"	—
Potentilla sp.	—	Leaves; flowers	Leaves
Xanthium strumarium	Last year fruits	Last year fruits	Fruit
Xanthium spinosum	" " "	" " "	"
Artemisia maritima	—	Flower buds	—
Isatis costata	—	Fruit	—
Eragrostis minor	—	"	—
Atriplex tataricum	—	—	Fruit
Ceratocarpus arenarius	—	Fruit	"

with milky juice (*Mulgedium*, *Chondrilla*, *Tragopogon*). While feeding the jerboas show the wastefulness common to the majority of wild animals, for they sever a stalk and eat a bit of it, only to repeat the whole process.

We did not detect any winter stores in the burrows of *Dipus sagitta*, an improvidence common to jerboas.

Hibernation.—We were not present for the emergence of *Dipus sagitta* from hibernation in 1935. This occurs at approximately the middle of March,

almost simultaneously with the reappearance of ground squirrels. Thus, according to the observations of M. Demiashev in 1935, *Dipus sagitta* awoke first on March 16, and ground squirrels on March 19.

A few days after their awakening the jerboas begin to mate, and proceed industriously to dig the summer burrows.

Preparations for hibernation begin with the construction of the winter burrows. In 1935, these preparations occurred in the last days of September. The jerboas, however, do not settle in the winter burrows before the eve of hibernation.

The stimulus for hibernating appears to be the fall in air temperature. Of importance also is the fatness of the jerboas, although *Dipus sagitta*, in contrast with some other hibernating rodents (marmots, ground squirrels), accumulates a relatively small quantity of fat. Thus, the average weight of adult females rises from 76.3 grams in April to only 90.4 grams in August, reaching in autumn a maximum of 112 grams; and the weight of adult males varies from 72.0 to 85.6 grams, with an autumn maximum of 102 grams.

In 1935, the great majority of jerboas entered hibernation between October 31 and November 2, which coincided with a sharp fall of temperature, winds and snow-storms. But late-born young, a certain proportion of which were yet juveniles less than 50 grams in weight, continued to lead an active life. We could observe their activity almost until our departure from the sands on November 17, although the night temperatures sank to −17 degrees C., the sand hillocks were covered with white frost, and the layer of frozen sand amounted to 20 cm. It may be that a certain percentage of the young of the year do not succeed in accumulating the amount of fat necessary for successfully surviving the winter, and so perish.

We dug out two jerboas that were in a state of hibernation. The first was taken from a burrow marked by us when it was being constructed, October 24. On the day of excavation, November 13, a considerable part of the passage proved to be blocked with a compact plug of sand. The walls of a short emergency exit, that ended at a distance of 10 cm. from the surface, were covered with a layer of white frost. In a small nest at a depth of 80 cm. we detected a hibernating adult female weighing 87 grams. The animal was sleeping squatting on its hind legs, the back turned to the entrance, with its head tucked under its abdomen and its tail curled around its body.

The other animal, a subadult, was dug out on the second day after the beginning of hibernation. The burrow was found on November 16, while following the tracks of its occupant. Its sign showed that the animal had prepared the burrow long ago, but had continued to live in its summer hole.

During the night of November 14 to 15, the jerboa had paid a visit to the burrow, and in leaving had trodden down the borders of its entrance (fig. 6). On the night of November 15 to 16, the animal began hibernating. After having excavated the burrow on November 17, we detected the nest chamber

at a depth of 113 cm. It was provided with a small amount of litter and the animal was sleeping in the same position as the individual mentioned above.

Both animals awoke quickly when placed in a warm room, but remained inert for a few hours after awakening.

In entering hibernation at the beginning of November and becoming active the middle of March, *Dipus sagitta* therefore passes about 4.5 months in hibernation, or 4 months less than the ground squirrels (*Citellus pygmaeus*) living in the same latitudes. This circumstance serves to explain the smaller amount of fat stored by jerboas than by the ground squirrels.

TABLE 4

REPRODUCTIVE ACTIVITY OF DIPUS SAGITTA IN 1932
(From data of Rall, Sheikina, and Demiashev)

	APR. 16–30	MAY 1–15	MAY 16–31	JUNE 1–15	JUNE 16–30	JULY 1–15	JULY 16–31	AUG. 1–15	AUG. 16–31	SEPT.	OCT.	NOV.	TOTAL
No. adult ♀♀ dissected...	3	8	14	12	23	17	11	15	23	39	17	0	182
No. pregnant.....	1	1	6	5	10	4	8	6	1	0	0	0	42
Per cent pregnant.....	33.3	12.5	42.9	41.6	43.5	23.5	72.7	40.0	4.3	0	0	0	
No. with recent young...	0	0	2	4	8	9	3	9	10	21	3	0	69
Ditto in percentage.....			14.3	33.3	34.8	52.9	27.4	60.0	43.5	53.8	17.6		

TABLE 5

REPRODUCTIVE ACTIVITY OF DIPUS SAGITTA IN 1935

	APR. 16–30	MAY 1–15	MAY 16–31	JUNE 1–15	JUNE 16–30	JULY 1–15	JULY 16–31	AUG. 1–15	AUG. 16–31	SEPT.	OCT.	NOV.	TOTAL
No adult ♀♀ dissected...	9	5	9	5	8	2	17	14	12	31	23	1	135
No. pregnant.....	1	0	1	1	2	2	5	8	1	0	0	0	21
Per cent pregnant.....	11.1	0	11.1	20.0	25.0	100	29.4	57.1	8.3	0	0	0	
No. with recent young...	0	0	1	1	3	0	6	2	8	24	8	0	53
Ditto in percentage.....	0	0	11.1	20.0	37.5	0	35.3	14.3	66.6	77.4	0	0	

Reproduction.—Dipus sagitta begins to mate soon after emerging from hibernation. As far as we could judge from the tracks, mating takes place above ground.

The extended reproductive period continues for more than 4 months. Pregnant females were caught from April 28 until August 27 in 1932, and from April 17 until August 17 in 1935. The analysis of our data indicates that the length of the reproductive period depends upon the following factors: (1) Variability in the start of reproductive activity of the females that have awakened from hibernation; for the females born late the preceding year probably breed later than thoroughly adult individuals; (2) second litters of young; and (3) the breeding of young females born in April of the current year. For these reasons the percentage of pregnant females in mid-summer is somewhat higher than in the spring (tables 4 and 5).

The question of the number of litters borne by the Dipodidae of eastern

Europe, and of the young of the year of *Dipus sagitta*, is not entirely clear. The fact of a second pregnancy in *Dipus sagitta* was established by us four times in 1936 (19 per cent of the number of pregnant females dissected). All four females excavated by us had suckling young, and upon dissection they proved again to be pregnant.

Small pregnant females born in 1935 and dissected by us in the same year also numbered four. Their age could be established easily by outward appearance, and besides, they differed from other pregnant females in weight (table 6).

Admitting a certain variability in weight according to age groups, and a factor of error of $\pm 3\sigma$, it is indicated that these smaller females do not belong in the same series as the other 17, and accordingly they must be considered as subadult.

TABLE 6

PREGNANT FEMALES OF DIPUS SAGITTA DISSECTED IN 1935

DATE	AGE	WEIGHT, GRAMS	NO. EMBRYOS	DATE	AGE	WEIGHT, GRAMS	NO. EMBRYOS
April 17	Ad.	83	3	July 28	Ad.	97	4
May 26	"	82	2	Aug. 4	"	94	3
June 7	"	88	2	Aug. 8	"	96	3[3]
June 21	"	80	3	Aug. 9	"	99	4[3]
June 30	"	84	3	Aug. 10	"	95	3
July 1	"	96	3	Aug. 10	Subad.	67	3
July 2	"	94	3	Aug. 11	Ad.	112	3
July 17	"	92	3	Aug. 13	Subad.	67	3
July 18	Subad.	69	3	Aug. 15	"	67	2
July 20	Ad.	88	4[1]	Aug. 17	Ad.	90	3[4]
July 25	"	99	4				

Four individuals were at the same time nursing; [1]two, [2]one, [3]four, and [4]three young of a previous litter.

Having determined that the arithmetical mean (M) for a series of 17 females is equal to 92.6 grams, and the mean quadratic deviation (σ), calculated according to the formula for the series with unrecurrent variants ($\sigma = \pm \sqrt{\frac{Ea^2}{n} - C^2\frac{n}{n-1}}$), equal to $\pm$ 7.6, we reach the following results for the four females in question:

NUMBER	WEIGHT	M	DEVIATION FROM $M(a)$	3σ	a-3σ
9	69	92.6	−23.6	−22.8	0.8
17	67	"	−25.6	"	2.8
18	67	"	−25.6	"	2.8
20	66	"	−26.6	"	3.8

In all cases the deviation from the mean exceeds 3σ.

The value to the species of repeated pregnancy and of reproduction by the females born in the current year is positive. It can be easily calculated that not less than 35 per cent of the annual surplus population of jerboas is secured by the reproductive activity of the examined categories of females. In fact, this percentage is even higher, for among the females dissected after having given birth to young (table 5), 7 must be referred to those born during the current year.

We do not know whether females of *Dipus sagitta* can reproduce more than twice a season, as was suggested by Kolesnikov (1934, p. 29) for *Allactaga elater* of Middle Asia. Taking into consideration, however, the fact that pregnancy lasts about 25 to 30 days (according to indirect data), that the development of the young is slower than in other species of small rodents, and, last, that *Dipus sagitta* is a hibernating rodent, one reaches the conclusion that in the Volga-Ural sands the individual females of the animal in question do not give birth to young oftener than twice a season.

As may be seen from a series of embryos, the fecundity of *Dipus sagitta* is comparatively poor.

Variation series of the number of embryos in Dipus sagitta

Number of embryos	2	3	4	5	M
Number of cases	17	50	10	3	2.9

The young jerboas live in the family burrows for a rather long time, and until attaining almost full growth. In some instances there was milk in the stomachs of young of 52 grams weight, which is the weight of subadults. At that weight individuals begin excavating their own burrows.

Behavior.—Dipus sagitta is nocturnal and crepuscular in habits. In spring and summer the animals on an average appear on the surface 10, 15 or 20 minutes after sunset, when daylight has not yet disappeared completely, and even just before sunset during the period of the longest summer days, in July. When the days begin to shorten, the emergence of the jerboas from their burrows is gradually delayed. Thus, in August the animals leave their holes 25 to 40, in October 45 to 60 minutes, and in November 1 to 1.5 hours after sunset. When the wind is high, the jerboas are 10 or 15 minutes later in appearing, and when it rains they are even later. But neither wind, rain, nor low temperature entirely prevents the jerboas from going out of their holes. The daily emergence of the whole population of animals takes place more or less simultaneously, but may be delayed for 15 to 30, and even for 60 or 75 minutes.

After having left the burrow, the jerboa either fills up the hole with sand, or leaves it open, and with long leaps travels to its feeding grounds, which may be at a distance of several hundred meters from the burrow.

In summer evenings we often observed the behavior of jerboas. Some-

FIG. 1

FIG. 2

FIG. 3

FIG. 1 (above). The shifting sands (barkhans). FIG. 2. The big sandhills, with *Elymus giganteus* in the background; habitat of *Dipus sagitta*. FIG. 3 (below). The small sandhills, with a wormwood steppe in the distance.

Fig. 4

Fig. 5

Fig. 6

Fig. 4 (above). The sand ejected from a freshly dug burrow is shown in the center. Fig. 5. A funnel of caved-in sand at the entrance to a burrow. Fig. 6 (below). A "rosette" around a winter burrow. The crack in the sand is from frost.

times we had 4 animals within sight at once. We cannot understand, therefore, the assertion of Vinogradov and Argyropulo (1931, p. 14), that it is impossible to see these animals on the surface at nightfall.

In feeding, the jerboa passes slowly from one place to another, with back bent and with legs strongly flexed, while digging for seeds and insects. In order to procure the ears of *Elymus giganteus*, they rise high on the hind legs and gnaw the stalks. After having satisfied its first hunger, the jerboa runs around its territory, visits its temporary burrows, meets another jerboa, and bathes in the sand. When meeting, the jerboas sniff and then chase each other, making bounds of about 2 to 3 meters; at an unhurried pace, however, their jumps average 30, 40, or perhaps 60 cm. in length.

In spring and summer the jerboa may be absent from its burrows during the entire night. One can determine this by the presence of only two pairs of foot prints at the entrance, one leading out and the other into the burrow. Then again, especially during the first autumn frosts, a jerboa may visit its burrow several times during the night.

At daybreak the jerboa returns to the burrow. In summer, the first animals disappear 50 to 60, and the last 15 to 30 minutes, before sunrise. *Dipus sagitta* therefore is absent from its burrow for from 9 to 9.5 hours. In case of frosts in November, however, the jerboas were not active for long at a time, sometimes for less than an hour.

Enemies.—Data regarding the enemies of *Dipus sagitta* are rather few. Individuals are either devoured, like other rodents, by species of Mustelidae (*Putorius eversmanni, Mustela erminea, M. nivalis*) or caught by foxes, and, naturally, also by raptorial night birds (*Athene noctua, Asio flammeus, Bubo bubo*). According to the data for 1934–1935, kindly furnished us by J. Rall, the bones of *Dipus sagitta* were found in the quite insignificant quantity of 1.4 per cent in the regurgitated pellets of raptorial birds (49 of *D. sagitta* among remains of 3453 other small mammals collected during two years). This percentage increases to 2.1 during the period of activity of the jerboas (April to October).

Dipus sagitta as an inhabitant of deserts.—This species exhibits two types of adaptation to the hard life incident to sandy desert and semi-desert habitats: exosomatic adaptations, and adjustment of behavior.

To the first group must be referred the following characters peculiar to all species of jerboas, as nocturnal dwellers in open spaces: elongated ears, large eyes, long whiskers, disproportionally elongated hind legs, reduction of toes on the hind feet, and a long tail with a white pencil on the tip. *Dipus sagitta* also possesses some other adaptations, especially adjusted to the life in shifting sand, namely a small brush of stiff long hairs on each toe of the hind feet, which allows it to rest upon a relatively greater surface of sand, and also a tuft of hairs guarding the external ear opening from the penetration of sand. These two adaptations do not exist in jerboas dwelling in localities with loamy soils.

Of great interest is the ability of jerboas to cope with shifting sand. With exceptional care the animal steps over the border of the burrow when leaving it. Operating with its head and fore paws, it pulls the sand to the orifice of the hole and thus closes it. Returning to the burrow, the animal opens the orifice and retreats slightly from its border, so that cascading sand forms a funnel over the orifice, without filling it or obliterating it. The digging capacity of *Dipus sagitta* is very high. We have been obliged more than once to abandon digging, either because of our inability with a shovel to overtake the burrowing jerboa, or because of the danger of collapse of the walls of the two or three meter excavation that had been dug.

On the surface of the sand hillocks the jerboa travels very easily, leaving feebly marked traces on the sloping sides compacted by the wind, or deeper imprints in the sand on the softer tops of the hillocks. But on steep, crumbling sides of sand hillocks, where the sand moves at the slightest touch, the jerboas slide down, furrowing the sand with their feet.

Of equal importance to the jerboas are the details of their behavior that can be considered as adaptations to life in a desert. The nocturnal and fossorial habits, their action in plugging the mouths of their burrows during the day, thus isolating themselves from the diurnal conditions of the surface, and their manner of placing their nests in a wet stratum of sand, allow them to avoid in large measure the desiccating effect of overdryness of the desert air, as well as the high daytime temperatures. As has been established already by the researches of Buxton (1923) and Williams (1924), the practical dwelling conditions of a good many desert animals differ sharply from the general climatic conditions of a particular district.

In fig. 7 is given the curves of daily fluctuations in the temperature of the sand at different depths, and of the air at 10 cm. above the surface. The jerboas do not encounter the high daytime temperatures of the air or of the superficial layers of the sand at all. Thus, at the depth of 15 cm. the daily temperature extremes are no greater than from 3 to 7 degrees C., and are quite insignificant in deeper layers, where the nests of jerboas are placed (table 7).

The jerboas leave the burrows at the hours when the temperatures of the air and of the deeper layers of the sand are closest to one another, and retire to the burrows before the daytime rise of temperature has begun.

A very interesting trait in the behavior of jerboas is the plugging of the burrows during the daytime. There are reasons for considering this procedure as an attempt to hide the holes. It is difficult to determine why, among all steppe rodents of U. S. S. R., the instinct for thus masking the burrows is strongly developed only in jerboas. Even in captivity, with a small wooden box for a refuge, the jerboas (*Dipus sagitta, Alactaga jaculus, Scirtopoda telum*) plug the entrance hole in the box with a piece of cotton-wool

furnished as nesting material. They do this even when the cover of the box is removed, and the nest lying exposed.

In early spring, when night temperatures are near freezing, hairy-footed jerboas, however strange it may appear at first sight, often leave their burrows open in the daytime. With the fall of minimum temperatures below freezing in September, the number of open burrows rose sharply and attained to 95 per cent in November. The curve for the spring months must have a higher peak. There are gaps in our observations for this period. J. Rall and M.

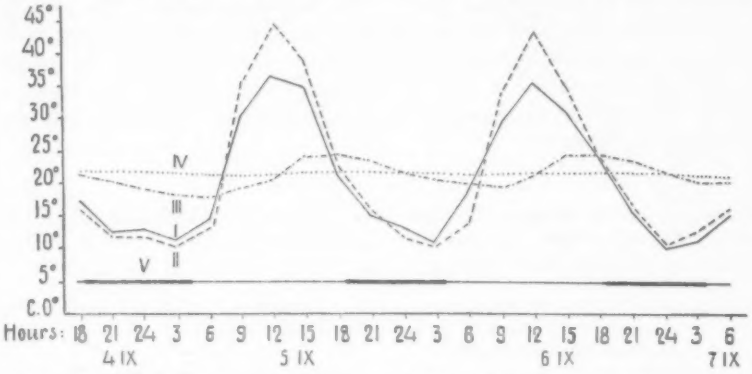

FIG. 7. Fluctuations of temperatures during 2.5 days in the habitat of *Dipus sagitta*. I (solid line), temperatures of the air 10 cm. above the ground surface. II (dashes), temperatures on the surface. III (dashes and dots), temperatures at a depth of 15 cm. IV (dots), temperatures at a depth of 60 cm. V Heavy lines, the periods of surface activity; and light lines, periods spent within the burrows.

TABLE 7

DEPTH TEMPERATURE FLUCTUATIONS OF THE VOLGA-URAL SANDS (NOVY USHTAGAN, 1935)

DATE	OF AIR 10 CM. ABOVE SURFACE	OF SURFACE	AT DEPTH OF 15 CM.	AT DEPTH OF 30 CM.	AT DEPTH OF 60 CM.
Sept. 5	26.1 C.	33.5 C.	6.3 C.	1.5 C.	1.0 C.
Oct. 6	24.5	24.8	7.5	2.7	0.5
Nov. 10	9.3	11.5	—	1.0	0.5

Demiashev, having at our request carried out supplementary spring observations in 1936 on the burrows of *Dipus sagitta*, found that jerboas do not plug their burrows for the several days of fasting after awakening from hibernation.

How may one explain these facts? We are inclined to consider that the purpose of burrow-plugging is not only for protecting the animals from enemies, but also to insulate the burrows from the high temperatures of the superficial layers of the soil and of the air. That is why *Dipus sagitta* does not plug the burrows during periods of low temperatures. An indirect

confirmation of this conclusion can be found in the established coördination between the moment when *Allactaga jaculus* emerges from its burrows in the evening and the temperature (Feniuk, 1929, pp. 14–16). In summer the jerboas emerge from their holes later on particularly hot evenings.

If, on the one hand, high summer temperatures cause the hairy-footed jerboas to plug their burrows, on the other hand the cool weather of autumn causes the little animals to place their nests deeper than in summer. The nest chamber is then not situated in the upper parts of the burrow as in summer, but in the terminal part of the deepened passage. The average depth of nests in summer varies from 45 cm. in April to 65 cm. in May–June, 80 cm. in August–September and 93 cm. in October–November. In coördination with this is the fact that the temperature of the sand at a depth of 60 cm. falls from 25 to 22 degrees C. in July–August, to 16 in October, and 4 degrees in November.

LITERATURE CITED

Boehme, L., and D. Krasowskij. 1930. Contributions a la connaissance de la vie de *Dipodipus Sagitta nogai* Sat. Ann. du Mus. Zool. Acad. Sci. U. R. S. S., vol. 31, pp. 419–430. (In Russian.)

Buxton, P. A. 1923. Animal life in deserts. London.

Feniuk, B. K. 1928. On the biology of jerboas (Jaculidae). Materials contributing to determine the fauna of the Lower Volga Region, pt. 2, pp. 49–91. (In Russian, with English summary.)

———— 1929. Still on biology of jerboas and methods of control at them. Ibidem, pt. 3, pp. 1–52. (In Russian, with English summary.)

Hatt, Robert T. 1932. The vertebral columns of ricochetal rodents. Bull. Amer. Mus. Nat. Hist., vol. 63, pp. 599–738.

Kolesnikov, I. I. 1934. Rodents injuring the rubber-plant Tan-saguyr. Middle Asia State Publ. House (Srednie Asiatskij Gos. Izdat.) Moscow-Tashkent, pp. 1–96. (In Russian.)

Ognev, S. I. 1930. Übersicht der in der russischen Fauna einheimischen Springmäuse der Gattung *Dipodipus*. Zool. Anz., vol. 91, no. 5–8, pp. 207–217.

Rall, Georg M. 1937. The relation between rodents and the mosaic landscape of the sandy semi-desert. Zool. Jour., (Zoologitsheskiy Jour.) vol. 14, no. 1. (In Russian with English summary.)

Smirnov, A., and S. Gougenotova. 1928. A la biologie des gerboises-*Dipodipus sagitta*. Comptes Rendus du premier congrès antipesteux de l'URSS, Saratov du 31 Mai au 3 Juin 1927, pp. 434–441 and 496–498. (In Russian, with French summary.)

Vinogradov, B., and A. Argyropulo. 1931. Matériaux pour servir à la connaissance des rongeurs de l'Asie Centrale. I. Observations biologiques sur les gerboises (Dipodidae, Mammalia). Ann. Mus. Zool. Acad. Sci. URSS, vol. 32, pp. 135–156.

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THE COLORADO RIVER AS A BARRIER IN MAMMALIAN DISTRIBUTION

By E. A. Goldman

The Colorado River region is of surpassing biological as well as of scenic interest, owing to diversified conditions of climate, geological structure, and topography. In this wonderland of titanic sculpture the full play of natural forces has resulted in the evolution, or close alignment, of a remarkable number of species and regional races along the opposing sides of the stream.

Speculation regarding the time element involved in present faunal adjustments led me to consult the late Dr. David White, former Chief Geologist of the U. S. Geological Survey, whom I knew to be an authority on the Grand Canyon. I asked Dr. White for a brief statement that I could quote. He replied that the information I desired had not been adequately covered in any publication, and suggested that I write him as he wished to give the matter some consideration. The reply to my letter, signed by W. C. Mendenhall, Director of the Geological Survey, under date of July 2, 1934, is such an interesting and important expression of authoritative opinion that I quote it in full:

"In view of the important use that you wish to make of the information requested, in connection with your biological studies, Doctor White has consulted with Messrs. J. B. Reeside, F. E. Matthes, H. E. Gregory, and N. H. Darton, of the U. S. Geological Survey, in order to present jointly the views of all these geologists. It is a matter of gratification to find that these men are substantially in accord on all essential points, and it therefore gives me pleasure to transmit this information as reflecting the practically unanimous opinion of all the geologists of the Survey who are familiar with the Grand Canyon region.

"The Grand Canyon of the Colorado River, so far as our present knowledge goes, is wholly or very largely the product of Quaternary stream erosion. The continental uplift that initiated the cutting began presumably with the dawn of the Pleistocene epoch, or possibly somewhat earlier, and the age of the chasm may therefore be stated to be, in round numbers, 2 million years (time being reckoned by the table of geologic time divisions published in Bulletin 80 of the National Research Council, 1931, the figures of which were adjusted to the most reliable age determinations of uranium-bearing minerals). The earlier chapters in the erosional history of the Grand Canyon region need not be considered in connection with your studies.

"There is reason to believe that the uplift that gave rise to the cutting of the Grand Canyon was most rapid in early Pleistocene time and that it slowed up later. Erosion by the Colorado therefore must have been most vigorous during the first half of the Pleistocene epoch, and it is a fair pre-

sumption that the chasm had attained considerable depth—as much as 4,000 feet, perhaps—by the middle of that epoch. It should be added that Gregory's observations in southern Utah would seem to warrant the inference that even before the Pleistocene uplift began the Colorado already had achieved a valley more than 1,000 feet deep in the Grand Canyon region.

"It is reasonably certain, further, that the Grand Canyon has gained but little in depth since the end of the glacial epoch—that is, in round numbers, within the last 20,000 years. Matthes in 1925 found in Bright Angel Canyon remnants of a gravel filling that must once have attained a depth of fully 150 feet. Similar remnants have since been found in other side gorges. They are so situated as to indicate that the gorges already had their present width and somewhat more than their present depth when the aggradation with gravel began. The bulk of the gravel has been re-excavated, but the process of re-excavation is not yet completed and considerable gravel still remains in the bottoms of the gorges. Gregory reports remnants of the same or of a similar gravel filling in Glen Canyon, in southern Utah. He and Matthes are agreed that the period of aggradation indicated occurred in Recent (postglacial) time. It may be inferred, therefore, that the depth of the chasm has remained essentially unchanged (barring the trifling changes due to aggradation and re-excavation) for a considerable period, probably throughout the greater part of the postglacial interval.

"The corollary is that the plateaus have had their present altitude practically ever since the end of the Pleistocene epoch. This stability of the plateaus during the postglacial interval may simplify your problem as regards the development of the present set up of climatic and life zones in the Grand Canyon region. If there had been an appreciable rise of the plateaus, there would have resulted progressive changes in the climatic conditions and corresponding changes in the fauna and flora. But as it is, it may reasonably be postulated that no such changes have occurred during the postglacial interval in consequence of either diastrophic movements in the plateau region or canyon deepening. Neither is it likely that the climatic conditions in the Grand Canyon region were appreciably affected by a further rise of the Sierra Nevada and of the other high ranges to the south of it. All these ranges attained substantially their present height before the end of the glacial epoch.

"To the glaciologist, in any event, it seems hardly thinkable that the present climatic and life zones in the Grand Canyon region date farther back than the beginning of the postglacial interval. During the last, or Wisconsin, stage of glaciation the climate of the Grand Canyon region doubtless was relatively severe. On the plateaus the snowfall must have been much heavier than it is now, and in the bottom of the Grand Canyon, where under present conditions snow falls but very rarely and never stays on the ground, snow then not only fell but lay for long periods every winter. The Lower

Sonoran life zone therefore was probably excluded from the chasm, and on the Kaibab Plateau the Transition zone was replaced by the Canadian zone."

The geological record thus enables us to postulate river barrier development extending back 2,000,000 years, and to visualize the Grand Canyon as having endured practically unchanged for perhaps 20,000 years. General observation also indicates that alterations in canyon contours are now very slow. Few fresh breaks are seen in the walls, and the condition of Indian cliff dwellings evinces but slight erosion in their vicinity. Vulcanism, however, has played a prominent rôle in comparatively recent time on both sides of the river. On the north side a lava flow down Toroweap Valley slipped over the canyon rim and ran down to the river. The canyon walls on either side of the lava appear to have remained unaltered since the date of the eruption.

During the rapid erosion accompanying the uplift of Pleistocene, and perhaps late Pliocene, time, the Colorado River entering the narrow Gulf of California from the east laid down in its delta the great dike that cut off the Salton Sea. In 1905, with Dr. D. T. MacDougal of the Carnegie Institution of Washington and two others, I descended the Colorado River from Yuma, Arizona, to the delta by boat during the spring flood. This expedition afforded us a clearer idea of the power of the river and of its rôle in building up the land surface in that region. The current was swift even in the delta, and the volume of water so great that we often found ourselves riding the crest in midstream several feet higher than the shores over which the water was spreading laterally. Although we were moving at a swift pace downstream we were obliged to keep rowing in order to steer clear of the banks, where tall cottonwood and willow trees were being undermined, and frequently fell with a crash into the stream. At this time the Colorado River was cutting for a considerable distance close along the foot of the mesa 100 to 200 feet high on the Sonora side, and tons of falling earth were a frequent danger. At one point we raced past a cut in the right bank, opened to carry irrigation water into the Salton Basin. A strong stream was flowing out, and later the entire river burst through and ran for about a year into the Salton Sea with results that are well known. The Southern Pacific Railroad, whose line was flooded, was reputed to have spent one million dollars in the struggle against almost insurmountable difficulties to turn the river back again to the present Gulf of California. When success finally came, the main stream did not resume the bed it had left but took a new course, probably along an old slough, 15 or 20 miles west of the route we followed.

The distribution of the mammals of the Lower Colorado Valley has been dealt with in considerable detail by Grinnell (1914). In the delta of the Colorado River shifting channels frequently transfer large colonies of bottomland-inhabiting mammals from side to side, as pointed out by the writer

(1931, p. 416; 1935, p. 153). Even here, however, the river and flood plain form an effective barrier for numerous species that find congenial habitats in desert environments on either side. Above Marble Canyon the river may freeze over in winter and some species that probably crossed on the ice have wide ranges on both sides of that section of the stream.

Four major life zones are represented in the Colorado River Valley, their altitudinal limits varying in accordance with slope exposure. Along the north wall of the Grand Canyon all are disposed in narrow horizontal belts, one above the other. The Lower Sonoran Zone occupies the entire lower part of the Colorado River basin from sea level on both sides to about 4000 feet altitude on average slopes, some zone elements extending in a very narrow strip up along the bottom through the Grand Canyon to the lower part of the canyon of the Little Colorado River. The Upper Sonoran Zone occupies a belt between 4000 and 6000 feet along Grand Canyon, broadening over the floor of Houserock Valley to the north, and the valley of the Little Colorado and the Painted Desert flanking Marble Canyon on the south. The Transition Zone includes the higher parts of the Coconino Plateau above about 6000 feet south of the Grand Canyon, and the Kaibab Plateau on the north side up to about 8000 feet. Above 8000 feet altitude on the Kaibab Plateau, Canadian Zone elements tend to predominate, especially on northern exposures, the higher elevations reaching about 9000 feet.

The present mammalian fauna of the Colorado River Valley up to points above the junction of the Green and Grand rivers, upper affluents that emerge from the Rocky Mountains, is an assemblage of species and subspecies some of which are undoubtedly the more or less modified survivors of Pleistocene or even earlier time; others may have invaded the general area, or developed there during the postglacial interval. The beaver (*Castor canadensis repentinus*) and the muskrat (*Ondatra zibethica bernardi*) are regional representatives of widely ranging aquatic species with no especial significance in the present connection.

The following species and subspecies range close along both sides of certain sections of the Colorado River:

Procyon lotor pallidus
Canis latrans mearnsi
Felis concolor browni
Lynx rufus eremicus
Citellus tereticaudus tereticaudus
Thomomys bottae albatus
Thomomys fossor
Perognathus penicillatus angustirostris
Dipodomys deserti deserti
Onychomys leucogaster melanophrys
Reithrodontomys megalotis megalotis
Peromyscus maniculatus sonoriensis
Peromyscus maniculatus rufinus
Peromyscus boylei rowleyi
Peromyscus truei truei
Peromyscus crinitus auripectus
Peromyscus crinitus peridoneus
Peromyscus eremicus eremicus
Sigmodon hispidus eremicus
Neotoma albigula venusta
Lepus californicus deserticola
Sylvilagus audubonii arizonae
Odocoileus hemionus eremicus

The mammals included in the foregoing list may readily be subdivided into two categories. One of these embraces subspecies that are semi-aquatic, or have habitats extending into the lowlands in the delta of the Colorado where shifting river channels must transfer colonies from side to side. These are *Procyon, Canis, Felis, Lynx, Citellus, Thomomys bottae albatus, Perognathus, Dipodomys, Reithrodontomys, Peromyscus maniculatus sonoriensis, Sigmodon, Neotoma, Lepus, Sylvilagus,* and *Odocoileus.* The other category is comprised mainly of upland forms with distribution areas on both sides of the river above Marble Canyon, where they may have used an ice bridge or found other passage across the upper branches of the river. These are *Thomomys fossor, Onychomys, Peromyscus maniculatus rufinus, P. boylei rowleyi, P. truei truei, P. crinitus auripectus, P. crinitus peridoneus,* and *P. eremicus eremicus.*

In the following parallel columns, species and subspecies inhabiting the western and eastern flanks, respectively, of the Colorado River Valley are contrasted. Worthy of special consideration is the fact that congeneric but distinct species may occur in close proximity on the opposing sides of the river. Some of these occupy distribution areas that have become detached, the animals presenting characters apparently due to genetic factors operating under isolation. Other species, evidently highly plastic, have ranges that are confluent on their side of the river, but they show the impress, especially in color, of their environment. The more sedentary forms inhabiting lava beds are usually very dark, while those burrowing in light soils are correspondingly colored.

Western or northern side	Eastern or southern side
Vulpes macrotis macrotis	*Vulpes macrotis arizonensis*
Felis concolor kaibabensis	*Felis concolor azteca*
Ammospermophilus leucurus leucurus	*Ammospermophilus harrisii harrisii*
Eutamias dorsalis utahensis	*Eutamias dorsalis dorsalis*
Eutamias minimus consobrinus	*Eutamias quadrivittatus hopiensis*
Eutamias adsitus	
Sciurus kaibabensis	*Sciurus aberti aberti*
Thomomys bottae centralis	*Thomomys bottae chrysonotus*
Thomomys bottae trumbullensis	*Thomomys bottae fulvus*
Thomomys bottae absonus	*Thomomys bottae aureus*
Thomomys bottae osgoodi	*Thomomys suboles*
	Thomomys muralis
	Thomomys alexandrae
Perognathus longimembris panamintinus	*Perognathus longimembris bombycinus*
Perognathus longimembris arizonensis	*Perognathus flavus fuliginosus*
Perognathus spinatus spinatus	*Perognathus flavus hopiensis*
Perognathus formosus formosus	*Perognathus apache cleomophila*
Perognathus formosus mesembrinus	*Perognathus apache caryi*

Perognathus parvus olivaceus	*Perognathus amplus rotundus*
	Perognathus amplus pergracilis
	Perognathus amplus cineris
	Perognathus amplus ammodytes
	Perognathus intermedius intermedius
	Perognathus intermedius phasma
Dipodomys merriami simiolus	*Dipodomys merriami merriami*
Dipodomys ordii cupidineus	*Dipodomys ordii longipes*
Dipodomys microps celsus	*Dipodomys ordii cleomophila*
Dipodomys microps leucotis	
Onychomys torridus pulcher	*Onychomys torridus perpallidus*
Onychomys torridus longicaudus	*Onychomys leucogaster capitulatus*
Peromyscus crinitus stephensi	*Peromyscus crinitus disparilis*
Neotoma cinerea cinerea	*Neotoma cinerea arizonae*
Neotoma lepida lepida	*Neotoma lepida devia*
Neotoma lepida monstrabilis	*Neotoma mexicana pinetorum*
	Neotoma stephensi stephensi
	Neotoma stephensi relicta
	Neotoma albigula albigula
Microtus mordax mordax	*Microtus mogollonensis*

Owing to peculiar environmental conditions, some of the species and subspecies ranging vis-a-vis on the opposing sides of the Colorado River deserve special discussion. The white-tailed ground squirrel (*Ammospermophilus leucurus leucurus*) and Harris's ground squirrel (*Ammospermophilus harrisii harrisii*) inhabit the desert upland over wide areas flanking the western and eastern sides of the lower Colorado, respectively. Xerophilous in habitat, neither extends into the lowlands subject to the vagaries of the river, but above the delta range on the mesas to the banks of the stream. Near Parker, Arizona, I found them living, each on its own side, at points only a few hundred feet apart.

Perhaps the most strikingly different but obviously allied animals with ranges separated by the Grand Canyon are the Kaibab squirrel (*Sciurus kaibabensis*) and the Abert squirrel (*Sciurus aberti aberti*). The Kaibab squirrel is restricted in range to the yellow pine forest of the Kaibab Plateau, which rises island-like to 9000 feet altitude on the northern side. South of the Kaibab Plateau the Granite Gorge of the Colorado is about a mile in depth, and it was in this vicinity that the greatest uplift occurred. Extensive erosion in other directions indicates that the Kaibab squirrel has been isolated since Pleistocene time. The Abert squirrel has an extensive range in yellow pine forest extending to the brink of the Grand Canyon on the southern side. Both the Kaibab and Abert squirrels belong to species not found beyond the confines of yellow pine forests.

The pocket gophers of the *Thomomys bottae* group range from the Pacific coast on the west to the Rio Grande Valley in Texas on the east. The group subdivides into an extraordinary number of species and subspecies, evidently

highly plastic or adaptable, as the collective ranges of the members extend from sea level to near timber line on the higher mountains. The link connecting a chain of forms east and west of the Colorado River Valley is *Thomomys bottae albatus*. This subspecies occupies a distribution area largely below sea level in the Salton basin, but it occurs close along both sides of the lower Colorado under conditions that point to transference from side to side by shifting channels of the river. Above the delta, however, the river is obviously a barrier as attested by the occurrence of three subspecies along the eastern and four along the western sides of the stream.

Three pocket gophers regarded as distinct species, *Thomomys suboles*, *Thomomys muralis*, and *Thomomys alexandrae*, with very limited ranges, appear to be isolated by local soil or rock barriers on the eastern side of the Colorado River. Of these, *Thomomys muralis*, within the Grand Canyon, is known only from the rim of the inner gorge and from a narrow shelf, bearing soil and vegetation, with nearly vertical cliffs above and below.

Unlike the highly adaptable and plastic pocket gophers of the *Thomomys bottae* group, *Thomomys fossor*, presenting little geographic variation, occurs in isolated colonies near the tops of the higher mountains on both sides of the Colorado River Valley. One such isolated colony inhabits the Kaibab Plateau. From the general evidence one may postulate that *Thomomys fossor* is a relict species of Pleistocene time.

Two genera of the family Heteromyidae, the pocket mice of the genus *Perognathus* and the kangaroo rats of the genus *Dipodomys*, present extraordinary development, with general lines of cleavage along the Colorado River, most notably in the vicinity of the Grand Canyon. The genus *Perognathus* has been traced back to the Miocene of California by Gazin (1930, p. 66). In describing *Perognathus furlongi* he remarked that it "is surprisingly similar to living species of the genus, considering the wide separation in time." Members of the genus vary greatly in choice of habitat, a distributional factor of especial significance along the lower Colorado, as we have seen. *Perognathus penicillatus angustirostris* burrows in the alluvial soil in the delta area and its occurrence on both sides of the river is, therefore, not surprising. *Perognathus longimembris bombycinus* and *P. l. panamintinus* range on the eastern and western sides, respectively, of the lower Colorado under conditions that suggest the possibility that one may have been derived from the other by transference of local colonies; but *Perognathus longimembris arizonensis* of Houserock Valley, on the western side, encounters a barrier in Marble Canyon. Four upland species with their subspecies, *Perognathus flavus*, *P. apache*, *P. amplus*, and *P. intermedius*, are widely distributed on the eastern side but their passage to the west is barred by the river or its flood plain. In general opposition to these, on the western side, are forms of *Perognathus spinatus*, *P. formosus*, and *P. parvus*. The upland species thus confronting one another across the river are all widely

divergent, and the time measure of their separation must be enormously long.

The kangaroo rats of the genus *Dipodomys* are represented in the region by several species that, with their subspecies, inhabit vast areas in the Southwest. Reference has been made to *Dipodomys deserti deserti*, which finds a congenial habitat in the soft soil of the lower Colorado flood plain, and for this form the river is no permanent barrier. *Dipodomys merriami*, in its numerous regional forms, extends from near the Pacific coast to Texas. As in the case of *Thomomys bottae*, there is evidence of a connecting link in a chain of eastern and western subspecies by the frequent alteration of direction taken by river channels in the Colorado delta. Sharply trenchant, on the other hand, is the separation of *Dipodomys ordii longipes* of the Painted Desert region, from *Dipodomys ordii cupidineus* of Houserock Valley, by Marble Canyon of the Colorado. The ranges of the western species *Dipodomys microps*, represented by *D. m. celsus* and *D. m. leucotis*, are bounded on the east by the canyons of the river.

Another group of wide general dispersal, the wood rats, is represented by various forms in the Colorado River basin. One of these, *Neotoma albigula venusta*, favors a habitat in the mesquite (*Prosopis*) timber on the lowlands along the lower Colorado, where colonies are frequently transferred from side to side by changes in river channels. For other members of the genus, however, the river along its main course is obviously a barrier. Within the Grand Canyon, and limited to the south or east side, four subspecies of wood rats occur along the wall between the canyon rim and the river in the bottom. These are *Neotoma mexicana pinetorum*, *N. albigula albigula*, *N. stephensi stephensi*, and *N. lepida devia*. The adjoining Painted Desert region, also on the east side, is the habitat of *Neotoma cinerea arizonae* and *N. stephensi relicta*. This assemblage grouped in such unusual proximity is faced on the north wall of the Grand Canyon by *Neotoma cinerea cinerea* and *N. lepida monstrabilis*. The bushytailed wood rat (*Neotoma cinerea*) is a northern species, and the occurrence here of two rather widely differing representatives separated by the river suggests that they may be somewhat modified survivors of Pleistocene or earlier time.

Other cases can be cited but this incomplete analysis of the mammalian fauna seems ample evidence that the Colorado River, bisecting the Southwest from the continental divide to the sea, has functioned for many thousands, perhaps millions, of years as an effective barrier for numerous non-aquatic and non-volant species and subspecies. The barrier thus established has been most insurmountable in the Grand Canyon section. Mammalian habitats flanking the stream vary from river alluvium and eolian sands to cliffs and lava beds, with the climate and vegetation embraced in four major life zones. The outstanding features of the river basin, the Grand Canyon

and its marvellous setting, afford unparalleled opportunities to the student of geographic distribution and the evolution of species.

LITERATURE CITED

GAZIN, C. LEWIS. 1930. A tertiary vertebrate fauna from the upper Cuyama drainage basin, California. Carnegie Inst. Washington Publ. no. 404, pp. 55–76. (Description of a Miocene *Perognathus*, p. 66.)

GOLDMAN, E. A. 1931. New pocket gophers from Arizona and Utah. Jour. Washington Acad. Sci., vol. 21, pp. 416–426. (Reference is made (p. 416) to the shifting channels and the transfer of areas from side to side along the lower course of the Colorado River.)

——— 1935. Pocket gophers of the *Thomomys bottae* group in the United States. Proc. Biol. Soc. Washington, vol. 48, pp. 153–158. (The rôle of the Colorado River as a barrier is indicated, p. 153.)

GRINNELL, JOSEPH. 1914. An account of the mammals and birds of the lower Colorado Valley, with especial reference to the distributional problems presented. Univ. California Publ. Zool., vol. 12, pp. 51–294. (General faunal conditions are fully treated.)

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MAMMALS ON ANTICOSTI ISLAND

BY WILLIAM MONYPENY NEWSOM

The Island of Anticosti lies in the western part of the Gulf of St. Lawrence, and is 135 miles long by approximately 35 miles wide, an area of about 3000 square miles. In 1680, it was granted by the King of France to Louis Jolliet as a seigneury, and since that time it has always been privately owned. Various attempts were made to colonize it but without success until it was purchased for $125,000 in 1895 by Henri Menier, French chocolate manufacturer. As Menier was much interested in shooting and fishing, he immediately stocked the island with mammals, as noted hereafter. Henri Menier died in 1913 or 1914, and his brother, Senator Gaston Menier inherited the island. It was sold by him to Canadian pulp interests for $6,000,000 in 1926; and after failure to realize any profit from pulp, it came into the hands of the Consolidated Paper Company, by whom it is now owned and operated, with island headquarters at Port Menier on the western end of the Island. At present, the income from the Island is derived from salmon fishing parties, a few tourists, and from trapping foxes, beaver, and other fur bearers. Few hunters visit the Island. No pulp operations have been carried on for several years.

The whole Island is of limestone formation. The southern shore is low, flat land that gradually rises toward the north. A high bench one or two hundred feet high follows the entire north shore. Sometimes this bench is a few hundred yards back from the beach, but every few miles it juts out in

high perpendicular cliffs that are called "capes" in the Island. Along much of the shore line there is a limestone reef that extends a mile or so to sea, which, with the lack of harbors, makes navigation somewhat hazardous.

About two-thirds of the Island is thickly wooded, but the eastern end is an open mossy plain. In the timbered section, the south shore is forested with spruce and balsam. There is some birch, practically no cedar, no hemlock, and a very few maple, cherry, and alder trees. On the north shore, spruce and balsam still predominate, but white pine and white birch are more numerous. Along the top of the cliffs mountain ash is also found. The timber is neither good in quality nor impressive in size.

The Newsom-Watson Expedition, of the American Museum of Natural History, visited Anacosti Island from September 15 to October 10, 1936. Our first stop was as Port Menier, company headquarters, in the western end of the Island and the only important village. From there we travelled about 25 miles down the south shore to Beescie River, and after a few more days at Port Menier, via motor boat around the west point and up the north shore as far as Vaureal River, a distance of 100 miles, making various stops along the way. We secured information on stocking the Island with game from early records and the reports of Mr. Menier's manager, Martin Zedee, as well as from other sources, as from Harold E. Graham, Island manager, Mr. Gerard, Menier's former general foreman, and some of the older inhabitants of the Island. In every case we have checked the information from several sources.

Anticosti is entirely lacking in many of the smaller mammals one would expect to find in spruce-balsam-birch country. There are no squirrels of any kind, no skunks, porcupines, raccoons, minks, weasels, fishers, wolverines, wolves, or wildcats on the Island. There are frogs, but no snakes.

There is an abundance of white footed mice (*Peromyscus maniculatus maniculatus*) on the Island, house-mice (*Mus musculus*) near Port Menier, and Norway rats (*Rattus norvegicus*) that have come in with the boats. There may be other varieties of mice which we did not find for lack of time, but trappers and hunters who are familiar with other forms on the mainland, told us they have seen none but white footed mice on Anticosti.

We could find no shrews. We showed several men colored pictures of shrews and they immediately recognized them and told us they had seen them on the mainland, but never on Anticosti. As we were very much surprised at the lack of shrews, we made repeated attempts to locate them, but without success.

In 1902–1903, Menier liberated 600 hares (*Lepus americanus americanus*). In 1936 they were not plentiful because of the usual seasonal variation in numbers. We saw none, observed very few signs, and took none in our snares. The large fox population, no doubt, tends to keep their numbers at a low ebb.

Muskrats (*Ondatra zibethica*) were introduced by the Company several years ago. They are said to be increasing.

Foxes (*Vulpes fulva fulva*) have always lived on Anticosti and Martin Hunter ("Canadian Wilds", Thomas A. Reynolds) recorded buying a good grade of silver fox pelt from there. The Company has on the payroll about 30 trappers whose chief duty is trapping foxes. At the Company's request, we took no specimens of foxes, but observed many of them, red, cross and silver. They are not a good grade of silver and the Company has released some males of better quality, hoping to improve the strain. Also the Company has a small fox farm on the Island. The annual take of wild foxes is about 1400; 15 per cent silver, 40 per cent cross, and 45 per cent red.

So plentiful are the foxes that it was found difficult to trap mice, the traps being regularly robbed by the foxes.

We believe the foxes and other fur-bearers would be more plentiful if red squirrels and chipmunks were introduced, as there is a lack of food for the fur-bearers at present.

Two fishers (*Martes pennanti*) were released by Menier a number of years ago, but trappers told us that one of these died almost immediately. The other was seen each year for a number of years. There are, however, no fishers on the Island at present, nor can we find any record of their presence before Menier bought the Island.

In 1912, Menier liberated 12 minks (*Mustela vison vison*). In 1926, Martin Zedee, Menier's manager, stated in a report that they were doing well and increasing, but the Company's trappers told us that the mink is now practically extinct.

Martin Hunter (loc. cit.), who was a Hudson Bay factor along the north shore of the Gulf of St. Lawrence, has stated that "The Martens [*Martes americana americana*] on this Island are peculiar and distinct in this manner, that almost without exception the forepaws and end of the tail is tipped with white hair. I traded one year several hundred pelts of Anticosti Marten and, with one or two exceptions, they all showed this distinction from those we got on the north shore mainland".

We could find no one on the Island, even among the old men who had trapped marten in their youth, who could confirm this story of white-tipped marten. We were told, however, that in the old days it was nothing for two men to take 300 or 400 in a season, as there was plenty of food for them, the whole place being "knee deep in rabbits."

There can be no doubt that marten existed in quantity on the island at one time, that they are now extinct or nearly so, and that they were not trapped out. The natives explain their extinction by saying that "When the deer were put on the island and became plentiful, great numbers of the deer died each winter. When the deer died, a marten would take up his residence in a hole beside the deer. He would then feed on the deer until

he became fat, stupid and a prey of vermin, whereupon, the marten died." This story was repeated to us by all the older inhabitants whenever the marten was mentioned, and apparently this myth was firmly believed by them. As Anticosti martens were dependent on hares during the winter (there being no squirrels), it is far more probable that a year of "rabbit disease" wiped out the hares and the martens starved to death.

In 1897 or 1898, 40 or 50 beavers (*Castor canadensis canadensis*) were liberated by Menier. Accounts differ as to the exact date and number. At present there are a fair number, and they are regularly taken by the Company's trappers.

Otters (*Lutra canadensis canadensis*) have always existed on Anticosti, but, as is to be expected, never in great quantity. Each year a few otters are taken by the Company's trappers.

In 1896, Mr. Menier released several bison (*Bison bison bison*), but these died in two years. Two more were released later, but these also died and the attempt at their introduction was abandoned.

Wapiti (*Cervus canadensis*) were introduced in 1903 and again in 1911, but they have not thriven. There are remaining but three cows that are very tame and constantly to be seen around Port Menier. The last remaining bull became dangerous a year or so ago and had to be shot.

In the time of Mr. Menier, 20 moose (*Alces americana americana*) were released at Jupiter River. These have done better than might have been expected, considering the lack of winter food. The number on the Island is usually placed at 250 individuals. We have no means of checking this figure, and we saw but one moose track, at McDonald River. We could find no one who could tell us where we could be sure of finding a moose, an indication of their scarcity.

From the character of the winter food, we believe moose will never become more plentiful, even though the Company continues to forbid their hunting.

One of our chief purposes in going to Anticosti was to learn more of the Anticosti bears (*Euarctos americanus americanus*). For many years there have been persistent reports that Anticosti possessed a new species of bear, in addition to the usual black bear. Martin Zedee, in a report to Mr. Menier, mentioned a separate species of bear but did not say in what way it differed from the common black bear. Martin Hunter stated that he bought a brown bear hide from Anticosti that was 9 feet long and 7 feet wide. George Allen England, in his book on the islands, also mentioned a new species of bear but gave no particulars.

While we were on the Island, we secured one black bear that was said to be a very large one for Anticosti. It measured five feet seven inches long. It has been examined by Mr. George Goodwin and pronounced by him to be a common black bear with no distinguishing features. The skull of another Anticosti bear was examined by him with the same result. On the Island

we examined four hides that showed no variation from the common black bear. At Vaureal River, Felix Poitras, the warden at that point, killed 9 bears in 1935 and 7 in 1934. He was one of the best hunters and most careful observers we have met among guides, and he told us that he could see no variation in the coloring or size of these bears.

As the late Henri Menier's enthusiasm for bear hunting is well known, we interviewed Bernard Le Jeunne, who was Menier's guide from the time he bought the island until his death. He told us that Menier had imported dogs especially for bear hunting, used to put out baits for them, and had killed quantities of them. He told us he had never seen any bear that he thought varied from the common black bear. We also talked to several other men who were native to the Island, and they all agreed that no variation from the common black bear had been seen or heard of by them. All agreed that bears, as well as otters, foxes, martens, and hares had always been found on the island.

Their statements are confirmed by early written accounts of the Island. All of these agree that there always has been a very large bear population on Anticosti.

Whatever the bear population may have been in the past, we believe it to be over-estimated at present. Only at Vaureal River has any considerable number of bears been killed in the past few years. As mentioned above, Felix Poitras killed 7 in 1934 and 9 in 1935. These were all killed while trying to break into the house at Vaureal where provisions were stored. In these two years there was little food for them and none of these bears were as fat as is usual in the autumn. Thus, in the opinion of Poitras, this represented a concentration of bears from the entire surrounding country.

When we were at Vaureal, the mountain-ash berries that grow along the cliffs of the north shore were plentiful, and bears were feeding on them. We saw the signs of no more than 3 bears, including the one secured. We saw the sign of another at Havre de Brick.

It is easily understood why bears are always said to be more plentiful at Anticosti than may actually be the case. They are fond of the crustaceans found in the kelp on the beach, and a bear will feed on the beach day after day. If 6 boats pass along the beach, the bear is observed 6 times, and after a short time when these people get together he is counted as 6 bears.

Charles McCormick, chief of the game warden patrol, who constantly travels the Island keeping in touch with the wardens, has given us the following figures as to the number of bears observed in 6 months by wardens at different points on the island.

At Havre de Brick	1	At McDonald River	2
At Fox Bay	2	At Carlton Point Light	3
At Salmon River	5	At Baie Martin	1
At Potato River	1		

Some of these, of course, may be the same bear seen several times.

From the above we have concluded that the bears of Anticosti are the common black bear without variation; that there never has been any other sort of bear on the island; and that the bear population of Anticosti is much over-rated and by no means extraordinary.

Deer (*Odocoileus virginianus borealis*) were first released on Anticosti in June, 1896, when 50 were brought by Menier's freighter, "Savoy", from L'Ilet, about 50 miles below Quebec. In July of the same year, 50 more were brought from Cap Chat. In the summer of 1897, 100 more were released and then 20 in November, 1897, a total of 220 deer.

There is, of course, plenty of summer food for deer, but Anticosti has 3 to 4 feet of snow in winter, and the winter food is very poor, consisting mainly of a small amount of vegetation on the wind-swept fields, Labrador tea on the plains, some browse, a small amount of balsam, some kelp on the beach, and gray tree moss found on spruce. The latter is made available by the constant very high winds that sweep the island, blowing down the trees. If it were not for this tree moss, we believe the island could not support half the number of deer in winter. As it is, the deer come through the winter in very poor condition, and the winter mortality is very heavy. The latter factor proves of decided advantage, for the Company kills but from 300 to 500 per year, and the winter kill keeps the number of deer within reasonable bounds so that over-browsing does not occur. The fact that the deer have a hard time surviving the winter is shown by the late shedding of velvet of the antlers. On September 15, we found nearly all the bucks still in the velvet. One that we killed September 16 was still in the velvet but beginning to shed. On September 18, we saw deer in the velvet and killed one that had shed.

The deer of Anticosti have had the reputation of being small. This is not a fact. No doubt, the lime in the soil offsets the lack of winter feed to some extent but the deer that we weighed showed the following weights:

Eight point buck: Live weight 200 pounds; dressed weight 143 pounds with all viscera removed.

Spike buck: Live weight 120 pounds; dressed weight 81 pounds.

Eight point buck: Live weight 240 pounds, dressed weight 176 pounds. Not considered a really large deer.

The bucks taken by the Company's trappers and wardens at Point Menier are all brought to the abattoire, weighed and sold to the Company's employees. The butcher in charge (and several others), told us many dressed bucks of 200 pounds are received, the largest he could remember weighing 220 pounds dressed. These deer compare favorably with the largest Adirondack bucks.

In the eastern part of North America, the large mature bucks usually have ten-point heads. Larger heads are usually ten-point base with extra, small points emerging from the main beam or main points. At Anticosti,

however, the largest heads are all of eight points. There is no variation from the eight-point standard, regardless of the size of the antlers. In this feature alone could we see any real variation in Anticosti deer.

Albinism is fairly common on Anticosti. We observed one yearling that was partly white, and we saw at Vaureal one hide that was largely so, but we doubt whether there is any more albinism on Anticosti than anywhere else where deer are equally abundant.

There is an amazing number of deer on the Island. The Company has estimated a quarter of a million for the 3000 square miles. We believe a more reasonable estimate would be 15 to the square mile for the wooded part of the island (about 2000 square miles) or perhaps 30,000 deer. As the deer have no enemies but the bears (negligible), and as the Company takes not over 500 per year, it is obvious that the winter kill must be very heavy to keep the deer population in bounds. We might add that during the first day we hunted, I counted 65 deer, and on the last day, 72.

We also checked the speed of the deer on the open fields near Baie St. Clair, by means of a stop watch and steel tape. A shot was placed under the belly to start the deer and to mark the spot. Time was again taken as the deer passed a land-mark. We found 15 to 18 miles per hour was the average speed. The deer were hurrying for cover, but were not fully extended. One year-and-a-half deer was chased by the speeder or motor hand-car on the lumber railroad. Both the deer and the speeder were fully extended. We later timed the speeder over a measured course at 28 miles per hour. We therefore believe that the speed of the average deer running from danger, where not *forced* to extend itself, is about 18 miles per hour, and that top speed, when hard pushed, is 30 miles per hour.

As Anticosti is of limestone formation, there are few large boulders, but scattered along the coast on the tidal flats are granite boulders, varying from 1 or 2 to 25 or 30 tons in weight. Seals use these boulders for resting places, and wherever they are found, there also are seals.

The seals in October at Anticosti are divided by the natives into two classes; the "horsehead" seal, which, according to report, grows 11 or 12 feet long, while all other seals that are not large are merely called "little seals". It was quite impossible to tell whether the smaller seals we saw were small "horseheads" or a separate variety of smaller seal. At any rate, the "horsehead" has been identified as the gray seal, four of which were collected.

We were told that these gray seals (*Halichoerus grypus*) have their young about the time of the first ice. Although we cannot vouch for this statement, the embryos secured were so well developed on September 24 that we can well believe it.

In the spring, the Greenland or harp seals (*Phoca groenlandica*) come to Anticosti and have their young, many of which are taken at that time. Mr. Graham told us that in the spring of 1936 they sold the skins of the

young for 7 dollars each. We were also told that the Hudson Bay Company have a large fox farm on the north shore and each year harvest seals for fox food. Seals are considered as vermin on the Island because of their fondness for salmon, and little distinction is made by the natives between species except as above noted.

We examined the stomachs of gray seals taken, but found them empty except for a few white worms about three-fourths to one inch long.

Another gray seal shot on the north shore at Kaplan Bay was a large one, and looked to be 9 or 10 feet long. We had a rope around it and observed it for a few minutes, but the rope slipped and it sank, as is usually the case with gray seals. It was a very light silver color.

There is a great deal of color variation in the gray seal. It ranges from very light silver to very dark brown or nearly black. The excellent and detailed account of the gray seal in Millais' "Mammals of Great Britain and Ireland" gives the maximum size of those he measured as 9.5 feet, but we believe the Anticosti seals are larger than this. Millais gives the time of the arrival of the young as from September 15 to October 15, states that the young are white when born, and live entirely on shore for about three weeks after birth. This may account for the natives of the island not *seeing* them until "about the time of the first ice". And if they are born white, they must change from the gray coat just before birth, as both embryos found were very dark gray.

When Menier first came to the island he expected to raise cattle, but they did not thrive and soon died. His veterinary blamed this on the dogs of the island, so in 1900 Menier had all the dogs deported and would allow none on the island thereafter.

The Island manager told us, however, that cattle still do not do well on the island. Horses do fairly well, but not as well as on the mainland. Sheep have been tried without success. Pigs are the only domestic stock that can be raised successfully.

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THE MUSKRAT AS NATIVE AND ALIEN

By Tracy I. Storer

The muskrat (*Ondatra zibethica*) has occupied a position of major economic importance in the fur trade of North America from colonial times to the present day. Its numerical abundance, wide distribution, and ease of trapping have resulted in the taking of millions of pelts, while locally the carcasses have been used as food. Despite this continuing levy, the species, unlike the beaver and some of the carnivores, has maintained its range and general population level, largely because of its fecundity. During recent years, interest in fur-farming has resulted in the escape and transplantation of the muskrat into areas where it was not native, not only in North America but also in Europe. Its appearance and spread on the latter continent during the last 30 years constitutes probably the most outstanding instance of successful acclimatization among mammals in the present century.

Native Distribution.—The native range of the muskrat, as mapped by Hollister (1911), includes the greater part of the United States and Canada. Some of the gaps then shown in its distribution have since been filled by further information from the field. The species, curiously, is lacking from certain seemingly favorable areas in the south-eastern and gulf states. In the arid west it is discontinuous in distribution, by reason of the localization of suitable habitat. It probably reached some of these now isolated waters during a period when aquatic and palustrine habitats were more widespread, in late Pleistocene or postglacial times. With subsequent contraction of habitat, stocks were reduced and isolated, since when limited subspecific differentiation has occurred. Parallel cases are known among amphibians and fishes in the western states.

In California the muskrat was native only to the Colorado River, along the Arizona boundary, and in scattered localities affording suitable habitat on the arid east side of the Sierra Nevada, from northern Mono County to central Lassen County. It was not present in the interior (Sacramento and San Joaquin) valleys, nor in the Modoc plateau. Newberry (1857, p. 62) was the first observer to comment on the suitability of these areas and their lack of occupancy by muskrats.

Some of these gaps in the original distribution of the muskrat are puzzling, since the species occurs in essentially similar habitats but a short distance away. Thus, in northeastern California the native occurrence at Eagle Lake, in Lassen County (of subspecies *mergens*), is less than 50 miles from suitable territory on Pit River in Modoc County. Parts of the Pit River drainage, as detailed beyond (Fall River Valley, Shasta County), have since

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proved eminently suitable. If muskrats had, in times past, reached the Pit River in northeastern California, they could very well have reached the Sacramento-San Joaquin basin, as they bid fair to do in the near future. Such gaps in distribution, where a species should occur "logically", only reflect our imperfect knowledge of the factors controlling animal distribution and emphasize the importance of the study of transplanted stocks.

Transplantation.—Transplantation of animals to new localities has been a feature of man's activities since before the dawn of recorded history. The dogs of the American Indians, several domesticated animals, and the rabbit and pheasant in parts of western Europe, are early instances of transplantation and acclimatization. Transfer of the muskrat to new localities began, so far as available records indicate, after 1900. The first conspicuous transplant was that into Bohemia in 1905. One instance in California apparently dates back at least to 1911. A majority of the records, however, are more recent, following the development of fur-farming. Interest in the possibility of farming muskrats probably arose from emphasis on the general decline in stocks of wild, fur-bearing animals, the success in the artificial rearing of silver foxes, and the development of the American fur markets following the world war. During the decade 1900–1910, little was said, in the literature, regarding depletion of the wild fur supply. Attention was focussed on the subject during the next decade, when numerous articles and books stressed the ever increasing market for fur, the decline in wild stocks, and the possibilities of fur-farming as a means of augmenting the supply. At the beginning of the century, owners of a few marshlands in eastern states had already recognized the value of the muskrats thereon, and such areas were treated as preserves, or "wild farms", from which a regular annual yield was obtained. In 1917, Lantz stated that the commercial value of muskrat skins individually was so low as not to warrant attempts at purely artificial production. Despite this and other similar statements, there developed, subsequent to 1920, a large popular interest in the possibilities of breeding muskrats under various artificial conditions. The matter, being new, was subject to little or no legal regulation. Interest in the capture, production, and sale of "breeding stock" increased. Fur journals carried advertisements of allegedly fancy breeding stock, offered at obviously fancy prices. The history of this endeavor has not been written fully and the extent to which wild stock of various subspecies was mixed is unknown. One farm in California was reported to have obtained stock from Colorado, North Dakota, and Ohio, thus possibly involving at least two subspecies; Alaska and Quebec muskrats are stated to have been crossed, and other admixtures are hinted, but whether these attempted hybridizations were successful is unknown. In several instances the original animals or their descendants have escaped or have been liberated in various localities. Whether "dealers" trapped their "selected breeding stock" from local marshes or

obtained it by purchase or exchange from other dealers is unknown. Little of a definite nature can be said concerning the muskrats now abroad in some localities, and future monographers of the genus may be puzzled by specimens from such areas. Inferences on subspecific differentiation in nature must depend on such material as was available to Hollister in 1911. For a few transplants the exact source is known; those that survive will show whether or not such introduced stocks will respond to new environmental conditions by change in characters.

A complete record of muskrat transplantations probably can never be written, since continued inquiry brings reports of a multiplicity of introductions and transplants. The stock in Germany, Austria, and Czecho-Slovakia is presumed to have descended from not more than two small introductions. If such actually be the case, it constitutes a record of successful acclimatization unequalled, as to smallness of original stock, by the alien rats of seaports, the European rabbit in Australia and New Zealand, or by the European house sparrow in North America. Furthermore, the results of the European transplant should serve, as do some other alien transplants, thoroughly to discount the theory of decline by inbreeding so dear to the minds of many sportsmen.

Transplant and Spread in Europe.—Details of the introduction and spread of muskrats in contintental Europe are available to American readers in part through a recent article by Mohr (1933). A voluminous literature already is in print on the subject in Germany, clues to which may be gained from the article just mentioned, and from the books by Toldt (1929) and Ulbrich (1930). Papers by Chappelier (1930; 1933), Hinton (1933), Pustet (1928; 1933; 1936), Munro (1931; 1935), Warwick (1934), and others provide information for England, France, Germany, and Scotland.

For many details regarding muskrats in Europe I am indebted to officials in charge of rodent control operations in the several countries here discussed. Through conversations in 1934, by literature supplied then and subsequently, and by answer to later inquiries, I was aided by Mr. E. C. Read in the Ministry of Agriculture and Fisheries at London; Mr. T. Munro and Mr. Hyslop, Scottish Department of Agriculture in Edinburgh; Dr. Martin Schwartz, Biologische Reichsanstalt für Land- und Forstwirtschaft, Berlin-Dahlem; Dr. A. Pustet, Bayerische Landesanstalt für Pflanzenbau und Pflanzenschutz, Munich; and Dr. A. Chappellier, Service des Vertébrés, Centre Nationale de Recherches Agronomiques, Versailles. Mr. M. A. C. Hinton of the British Museum (Natural History) aided my studies in England.

Beginning at Dobrisch, about 25 miles southwest of Prague, Bohemia, in the spring or autumn of 1905, a few (2.5 to 10) pairs of muskrats from Canada were released. From this center the species has spread in ever-widening range, like the ripples from a pebble thrown into a pond, until now this alien rodent occupies an enormous territory covering Czecho-Slovakia and

much of Germany (fig. 1). In addition, it has spread into Austria and to Poland. Muskrats have been captured on at least one occasion in Switzerland and a center, from a separate source, has been established in eastern France near Belfort.

Under the more rigid economic limits of life and sustenance for people in central Europe, the interpolation of any new element arouses concern. As early as 1912, attention was directed to the potentialities of the muskrat

FIG. 1. Spread of the muskrat in central Europe. Original introduction in 1905, southwest of Prague in Bohemia (now Czechoslovakia). Areas occupied in succeeding years are outlined. Regions freed of muskrats in 1935–36 in western Bavaria and Saxony surrounded by dotted lines. Adapted from Ulbrich (1930) and Pustet (1936).

for harm. The countries of western Europe with much rainfall have extensive drainage systems to dispose of excess water. The principal damage by muskrats involves burrowing in canal banks, railroad fills, and earthen dams. Culture of carp and other fish in ponds is an established industry in Germany, and muskrats have damaged such ponds and caused holding dams to break with consequent loss of water and fish. In a few instances they are reported actually to have eaten carp.

Germany.—The entrance of the muskrat into Germany was a natural consequence of the spread from Bohemia. There are no sharp biological barriers and the waterways crossing international boundaries afforded every opportunity for spread of muskrats. Ulbrich's (1930) chart shows clearly that the increase of territory occupied was a natural spread. By the time control measures were instituted in Bavaria the species already occupied a wide extent of waterways. The work in Bavaria (1917) was, so far as I can ascertain, the first major attempt at control, and time was lost in development of suitable methods and administrative procedures. In addition, publicity was needed to arouse the interest of farmers and other people on the land regarding the potentialities of the muskrat. It seems evident, from perusal of the German literature of the period, that no hope was held of being able actually to exterminate the muskrat, but early in the work a defense line (Sperlinie) was established (München, Regensburg, Nürnberg, Bamberg, Lichtenfels) along which it was hoped that trappers might resist advance to the west. Despite considerable expenditures (for example 34,671 RM or about $8668 in 1927) this proved impossible, and muskrats spread beyond the line. The world-wide economic depression reacted unfavorably on the control program by decreasing the funds available in subsequent years for payment of trapping premiums and employment of trappers, while interest on the part of private trappers declined with reduction in pelt values. In 1927 muskrat pelts brought the trappers 5 to 7 RM ($1.25 to $1.75) each, while in 1929 this declined to a figure as low as 1 RM, rising then to 2 or 3 RM. In 1934, when I visited Munich, work was still in progress, at a cost of from 30,000 to 35,000 RM annually (A. Pustet, personal communication, March 20, 1934). Meanwhile, interest in the spread of the muskrat through Germany continues, and each year there appears in an issue of the "Nachrichtenblatt für den Deutschen Pflanzenschutzdienst", issued at Berlin-Dahlem by the Biologische Reichsanstalt für Land- und Forstwirtschaft, an article summarizing the yearly change. This information is kept down to date on a spot map in the Biologische Reichsanstalt. Each year's article includes a map of the current distributional situation and notations regarding new records of muskrats in the various states of the Reich. It is my impression that the agricultural officials are now reconciled to the continued presence of the animal and that future effort will endeavor to hold the numbers down by official trapping and by continued stimulation of public interest. It now seems impossible that the countries of central Europe can ever hope actually to rid their lands of the muskrat. The species will not only hold much of the territory already occupied, but may continue to spread and, in time, to occupy most of continental Europe suitable for its existence.

When interest was aroused in Germany over the possibility of damage by muskrats to earthworks, numerous state and local governments passed laws placing the animal in the nuisance category and making conventional stipu-

lations regarding notification of presence and control by landholders. Many of these are reprinted by Ulbrich (1930).

In Bavaria, Prussia, and Thuringia, trappers have been paid by the State; in Saxony the hunters have been under State license and were paid only bounties but were allowed to sell the pelts taken for their own account. Bounties there in 1934 were 30 to 50 pfennigs per animal, and more where muskrats were scarce. Trappers wear a distinctive armband. Officials have to guard against trappers leaving small "nuclei" of muskrats for future breeding. A total of 137 licensed trappers was operating in Saxony during 1934. The annual damage in the Reich was estimated at 70,000 RM, these costs being borne by the Ministries of Agriculture, Railways and Public works (Ernahrung [incl. Landwirtschaft], Eisenbahn und Verkehr) because railroads, embankments, road structures, bridges, and waterways all are state-owned. Many applications were made earlier, especially by small landholders, for permission to establish muskrat farms, but these were refused and the law now provides penalties for keeping muskrats in captivity. Entry of muskrats through customs now is prohibited by law, but due to ignorance of the species by customs inspectors, difficulties are experienced in enforcement; muskrats have, at times, even been declared as rabbits or guinea pigs. Control operations in Germany were conducted by the individual states until 1935, but in that year operations were consolidated for the Reich and Dr. A. Pustet, earlier in charge of work in Bavaria, undertook direction of the general program (M. Schwartz, letter, March 17, 1937).

In Bohemia, muskrats are believed to have reached an equilibrium as to numbers. The animals do less damage to waterways there, since many of the structures are reinforced with stone. In Germany, many waterways are earth-lined; hence greater damage is possible (M. Schwartz, April 13, 1934).

Other Continental Countries.—Muskrats have appeared in other countries of Europe, including Austria and Hungary. In France, muskrats escaped from a farm near Belfort and in the Department of Ardennes (A. Chappelier, January 15, 1934). In 1937, the territories of Belfort and Bas-Rhin were occupied; trapping had been employed to hold the animals in check and experiments with virus were being conducted (A. Chappelier, letter, March 15, 1937).

The species has been introduced into Finland in Kronoby near Wasa (1922), and in Ylivieska and Tuulois (1923). This is a region of many lakes. The annual spread of 30 to 40 km. has been aided by trappers and already a number of pelts have been taken. Thus far the benefits outweigh the damage (Mohr, 1933, p. 62).

In Poland, muskrats first appeared during the winter of 1929–1930 in Oberschlesien, in the Kreissen of Rybnik, Teschen, and Pless. By 1933 they were in Wojewodschaff Kielee, in former Russian Poland. First efforts

at control were made in 1932, and in that year a law was passed against human aid in spreading muskrats, with a fine of 2000 zloty or 6 weeks imprisonment. (Dr. Christiana *in* Nachrichtenblatt für den Deutschen Pflantzenschutzdienst, vol. 13, p. 108, 1933.)

There is one report of a few muskrats having been taken in Switzerland on or near Vierwaldstätter See, but no statement of further occurrence has been noted for that country. Muskrat farms are said to have been established in Belgium. (M. Schwartz, April 13, 1934.)

A recent article by van Poeteren (1934) entitled "De bisamrat nadert onze grens"—The muskrat nears our border—indicated that the Netherlanders are concerned over the potentialities for harm by this rodent to the all important dikes and dams of their country; the species was then reported to be only 58 miles away.

I am uncertain regarding the current status of the muskrat in Russia. I have seen statements as to possible introduction, and two articles appeared in the Zoölogitscheskij Zhurnal in 1933 on the biology and food habits of muskrats. A firm known as "British Rabbit and Fur Farmers" near Maidstone, in Kent, is reported to have imported and transhipped muskrats to Russia (M. A. C. Hinton, April 20, 1934). Eyerdam (1932, p. 281) reported shipment of muskrats from Ontario to Petropavlovsk, Kamchatka in 1928.

British Isles.—In the British Isles, muskrats were introduced into Scotland in 1927, and into England in May and June, 1929, at Shoeburyness, Essex. But an even earlier introduction is reported at Great Missenden, Buckinghamshire. In Ireland, muskrats were imported to County Tipperary in July, 1927. Early in 1930, M. A. C. Hinton and E. C. Read had 76 records (including some unconfirmed reports) of places where muskrats were or had been kept. At first, according to Mr. Read, certain government officials considered that muskrat farming constituted a new and useful industry meriting encouragement. Soon, however, this viewpoint was reversed, due to the escape and rapid spread of the rodents, coupled with adverse opinions by Messrs. Hinton and Read and other mammalogists conversant with the potentialities of the muskrat for harm, as hitherto demonstrated in Germany. On March 17, 1932, the Destructive Imported Animals Act was passed by Parliament. This placed the importation and keeping of muskrats under control of the Minister of Agriculture and Fisheries in England and the Secretary of State for Scotland. A Statutory Rule and Order (no. 153) promulgated by these officials, effective May 1, 1932, in England, Wales, and Scotland, provided for licensing of muskrat owners and conferred on officials the right to destroy muskrats found at large. Penalties were provided for non-compliance, and owners as of June 24, 1931, who were refused licenses, were given permission to apply for compensation for loss of investment. Only 14 licenses were issued. In March, 1933, an order effective

April 1, 1933, prohibited absolutely the importation or keeping of live muskrats in Great Britain. Similar laws were passed for the Isle of Man and by the Irish Free State (E. C. Read, May, 1934; Warwick, 1934, p. 251).

Warwick (1934) had record of 76 places in England, one on Isle of Man, 10 in Scotland, and one in Irish Free State where muskrats had been kept. Animals escaped from 12 of these and centers of infestation developed in 5 localities, namely, Shrawardine, Shropshire; Farnham, Surrey; Pulborough, Sussex, England; Feddal, Perthshire, Scotland; and Nenagh, County Tipperary, Irish Free State.

Governmental control campaigns were instituted in 1932 and 1933 in all these places. Field crews were organized, Herr Roith, the highly successful Bavarian trapper, was "borrowed" to demonstrate field techniques, and a thoroughgoing program looking toward actual elimination was instituted. In England, the crews were equipped with motor trucks capable of carrying a boat, and general reliance was placed upon trapping. The Roith technique ("Stöberfang"), involving use of a probe inserted from above ground on the bank containing a burrow, with wire catching cage at the burrow mouth, was used in part. A special type of burrow-entrance trap was developed (fig. 4). In addition, two ingenious types of floating traps were developed, use of which was chiefly to indicate presence of muskrats rather than as a means of extermination (fig. 5).

In England, prior to 1932, an estimated 1500 muskrats were taken by private individuals. The official campaign there resulted in the capture of muskrats as follows:

	Shropshire (Salop)	*Pulborough, Sussex*	*Farnham, Surrey*
1932	1,531	—	—
1933	1,064	144	39
1934	181	8	12
1935	7	1	1
1936	1	0	0
Totals	2,784	153	52

The annual costs (financial year ending March 31) were:

1932–33	£2913
1933–34	£6519
1934–35	£4200 (estimated)
1935–36	£2750
1936–37	£1050 (£100 recoverable by sale of equipment)
Total	£17,332 [= $84,580]

Each muskrat taken cost $28.29. The campaign was terminated on March 31, 1937 (E. C. Read, letter, March 17, 1937).

Similarly, the control of muskrats in Scotland involved:

	Expenditures		*Muskrats Taken*
1932–33.....	£840	1932.....	51
1933–34.....	2,600	1933.....	764
1934–35.....	2,900	1934.....	154
1935–36.....	2,240	1935.....	7
1936–37.....	1,100	1936.....	2
1937–38.....	200	1937.....	—
	£9,880 [= $48,610.80]		978

Each muskrat taken, therefore, cost $52.43. The Scottish campaign was to be closed before June 30, 1937 (T. M. Munro, letter, April 14, 1937).

The campaign in Scotland showed some of the problems involved in efforts actually to rid an area of a pest; the area was small and subjected to careful scrutiny, so the numerical details probably are quite accurate. Governmental operations began in October, 1932. During 1933, the staff of trappers was increased from 4 to 13 and a supervisor, remaining thus through 1934. The animals taken were:

	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTALS
1933	14	47	72	51	51	57	40	78	135	104	62	53	764
1934	27	19	13	11	17	19	9	5	10	4	13	4	154

Early in 1933 there were not sufficient trappers to control natural increase; as the staff increased and became more efficient, the population was far reduced. Only three family groups were taken in the latter half of 1934; all others were stragglers. In 1933, rats were taken in 38 squares of the Ordinance Map, in 1934, in only 23 squares. Yet at the end of 1934 it was considered that rats might occur anywhere within an area of 400 square miles. With decrease in physical labor of trapping, fewer men were employed, but need for even more careful scrutiny and inspection increased Motorcycles were provided to aid this phase of the campaign (Anonymous, Scottish Jour. Agric., vol. 18, pp. 175–178, 1935).

The difficulties involved in a final clean-up were illustrated in an artificial pond, Loch-an-Erie, at Gleneagles Golf Course. In March, 1933, Herr Roith, the Bavarian trapper, saw a burrow there, but trapping produced no results. This burrow was watched and in August, 1934, evidence of occupancy was noted; again trapping was unfruitful. There was no sign in late October. A flood then occurred on River Earn, after which the loch froze over. On November 8, another trapper saw bubbles beneath the ice, indicative of muskrats. Five muskrats were subsequently caught in the loch (Munro, 1935, p. 12). Whether the pond was continuously occupied or reoccupied with the flood was not known.

The need for continued scrutiny of old burrows is obvious. Control workers in England preferred not to collapse such burrows but to leave them; fresh occupancy by rats missed earlier could then be detected more readily. When muskrats obtain food from under water and eat or store it in deep burrows, or when they feed at a distance from the burrow, detection is difficult.

During the campaign in Scotland a considerable variety of other animals was taken in the trapping operations, including (up to September 29, 1934) 1745 brown [Norway] rats, 2305 water voles, 57 weasels, 36 stoats, 2178 moorhens, 113 ducks, and miscellaneous other birds such as 23 seagulls, 13 each of curlews and redshanks, 28 snipes, 15 European blackbirds, and one eel—a total of 6587 animals, including both harmful and beneficial species (Munro, 1935, pp. 11–16).

For the Irish Free State, exact details are not available, but "several hundreds" of muskrats have been taken (E. C. Read, letter, March 17, 1937).

Current Status in Europe.—In summary, according to information now in hand, it seems entirely probable that muskrats have been or will be entirely exterminated in England and Scotland. Success, if attained, will be due to the relatively small areas involved, to the nature of the terrain, to the adequate financial support of the government, and to the industry and persistence of the personnel involved. In continental Europe, the muskrat probably will remain as an acclimatized alien of dual importance, useful as a fur bearer but harmful in varying degree to earthworks, water channels and fish ponds. A review of the efforts to date in Germany shows that earlier, despite earnest endeavor with moderate financial support, spread of the species beyond the Sperlinie established in Bavaria had not been checked. Under concerted action in 1936, however, slight reductions were made in extent of territory occupied (Pustet, 1936).

Transplants in North America.—Turning to North America, details as to spread of the muskrat by the aid of man are available for British Columbia and for California.

Muskrats were native to the mainland of British Columbia but not on Vancouver Island. In 1923, small numbers were liberated on the Island in the Cowichan Lake district by the Provincial Game Commission. Their status in subsequent years was briefly as follows: 1925—increasing; 1926—also in Somenos Lake and sign on Saanich Peninsula; 1927—increasing; 1928—also near Port Renfrew; 1929—several reports of muskrat damage to crops and lands in Cowichan and Saanich districts; 1930—increasing rapidly, many damage complaints, special trapping permits issued to farmers; 1931—catch of muskrats on Vancouver Island about 9000 pelts; 1932—on increase, many permits to farmers during closed season; 1934—many taken for fur, farm complaints lessened; 1935—few farm complaints and fewer taken by

fur trappers. (Summarized from Reports of Provincial Game Warden, later Provincial Game Commission, 1923–1935, inclusive.)

It is also reported that muskrats were planted at Miller Creek, Forbes

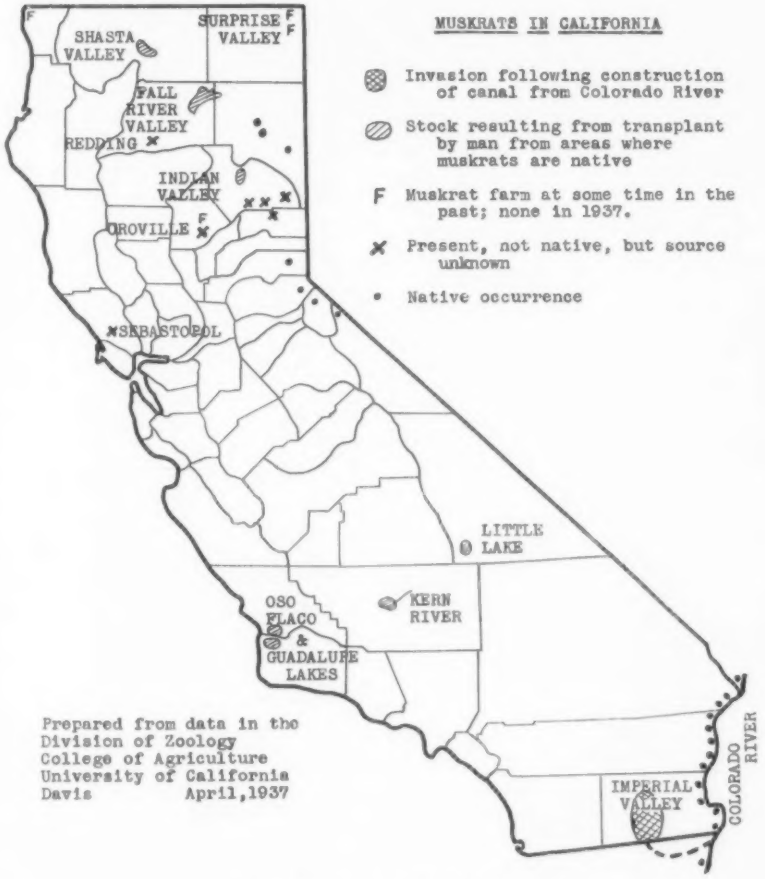

FIG. 2. Muskrats in California, 1937

Landing, close to Campbell River, 6 in 1923 and 6 in 1924. Creeks and swamps south of this locality subsequently became well populated and crop damage due to muskrats was reported in 1931 (Ronald M. Stewart, B. C. Police, Atlin, letter, December 4, 1931). In 1933 they were reported north

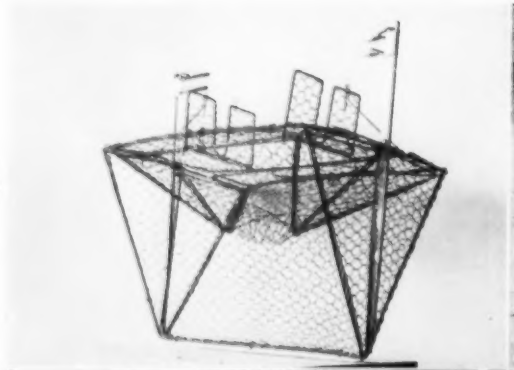

Fig. 3

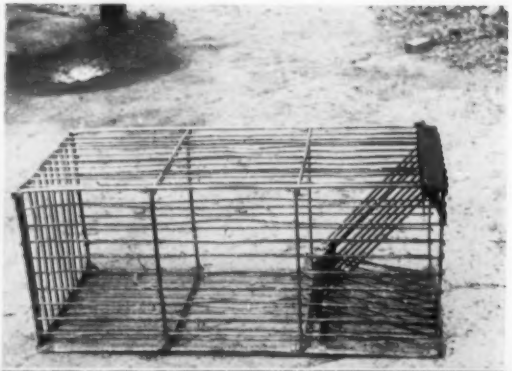

Fig. 4

Fig. 5

Fig. 6

Muskrats in Europe and California. Fig. 3 (upper left). Collapsible wire-screen trap to be set in water on route of swimming muskrats (used in Germany). Fig. 4 (upper right). Cage trap with "door" of individual wires at right. Set at mouth of burrow to catch muskrats driven out by probing in bank (used in Shropshire, England). Fig. 5 (lower left). Floating trap for muskrats set at margin of quiet stream. The floats are metal tubes sealed at ends (used in Surrey, England). Fig. 6 (lower right). Perforations due to muskrat burrows in dike about spring used for irrigation (Fall River Valley, Shasta County, California).

to Comox and also as introduced on Denman Island (T. Pearse, Courtney, June, 1933).

Muskrats were also planted on Graham Island, in the Queen Charlotte Islands, in 1924 or 1925, near New Massett and probably elsewhere. In 1933, at a site fully 30 miles from the place of introduction, a muskrat made nightly visits to catch fry of pink salmon at an experimental counting screen. Dikes in Tlell River, erected to hold back salt water, were reported to have been damaged (Pritchard, 1934, p. 103).

The first important translocation of muskrats in California followed as a natural consequence of building (1901) the International Canal carrying water from the Colorado River to the then desert Imperial Valley. While earlier there may have been occasional muskrats in the region (cf. Mearns' observations in 1894), the construction of more than 300 miles of mainline canals and numerous small ditches, with subsequent inevitable growth of aquatic vegetation, provided an admirable extension of habitat for this species. The first were noted about 1905. E. A. Goldman saw many holes in irrigation banks in June, 1907, and in 1915 L. J. Goldman said damage had been caused and the irrigation district was paying bounties of 50 cents to $1.00 per head. In 1921, Joseph Dixon studied the muskrats in the Valley and obtained reports of 20 to 40, and exceptionally 200, muskrats per mile of canal. He concluded that the pocket gophers, which had also increased, were responsible for more damage, by burrowing in canal banks, than the muskrats (Dixon, 1922). Nevertheless, the officials of the Imperial Valley Irrigation District considered that muskrats caused damage by burrowing in banks between adjacent parallel canals and around headgates (where wire mesh had to be inserted to check burrowing and the gnawing of wooden gates). From 1925 to 1932 the District paid $33,204.50 in bounties on 139,012 muskrat tails at 12.5 (to mid-1927) and 25 cents per animal. Some unrecorded bounties had been paid earlier. The system was abandoned in 1932 because of financial difficulties. One break in the canal system cost $5000 to repair (MS data from District Manager, 1935). Under favorable conditions of fur prices, as in 1919–1920, Dixon figured that 25,000 muskrats (estimated to be half the local population) were taken annually in the valley at $1.25 per pelt, yielding $31,000; this would amount to far more than the damage (Dixon, 1922). Damaged structures, however, must be repaired at the expense of the district, whereas income from muskrat furs accrues to private trappers. Furthermore, private trappers have less incentive to work during seasons of low prices, and always prefer to trap where animals are abundant rather than in critical areas where smaller numbers of the rodents may be causing damage. Replacements in the population are rapid, breeding being reported in Imperial Valley for every month in the year, but especially from about February 15 to October 30, with possibly 3 broods averaging 6 (3 to 9) each.

As previously mentioned, under original conditions in California, muskrats occurred only on the east side of the Sierra Nevada in scattered localities, and in the Colorado River. Transplantation or escape of captives has now resulted in establishment of muskrats in several places west of the mountains. Some of these localities are so isolated from other drainage basins that there is little likelihood of the animals radiating and establishing new centers; other colonies are on tributaries of the Sacramento-San Joaquin drainage system. The known transplants in California are:

Colorado River at Needles, San Bernardino County.—William Pugh reports that he introduced 75 muskrats (subspecies unknown) purchased from dealers in Oregon, Montana, and Ohio, in 1930 to 1933. These were darker animals, planted in the hope that they would hybridize with the local *pallidus* (=*bernardi*) and result in pelts of higher fur value (E. R. Hall, Mus. Vert. Zool. field notes, February 1, 1934).

Kern River and Buena Vista Lake, Kern County.—Muskrats, presumably of subspecies *mergens*, were introduced in 1911 or earlier. The actual date, source and means are unknown. The population increased and considerable numbers are reported as taken for fur; later control measures were used against the animals. In the winter of 1936–1937, it was stated that few or none were left; the lake had been dry for several years and irrigation canals at Bakersfield, formerly occupied, had been dry for a long period. Later in 1937 the lake was partially filled with water.

Guadalupe and Oso Flaco lakes (west of Santa Maria, Santa Barbara County).—W. N. Morrison in 1927 introduced 149 individuals of the race *pallidus* (=*bernardi*) from Imperial Valley into Guadalupe Lake at Betteravia. At first the animals multiplied, but with a succession of dry years the lake dried up. Some muskrats migrated to pools and swamps at the outlet of the lake and the Santa Maria River. Black Lakes, south of Oceano, San Luis Obispo County, also were planted with muskrats to reduce the growth of tules. The Santa Maria Valley is irrigated from wells, only excess water appearing in surface ditches, and the drainage basin is far removed from other streams. No damage to agriculture has resulted; a few hundred pelts were taken in 1936; predators are reported to capture migrating muskrats, and some were run over on highways by automobiles.

Little Lake, Inyo County.—William Bramlette imported individuals of the race *pallidus* (=*bernardi*) in 1928 to reduce cat-tails in the lake, which they have done; some have migrated along a connecting stream that sinks in the adjacent desert. No damage has occurred and the animals are far from other water or agricultural areas.

Lagoon near Sebastopol, Sonoma County.—Two animals were trapped in the winter of 1935–1936; no further information is available.

Taylorsville, Plumas County.—W. H. Stanfords established a muskrat farm in Indian Valley in 1925, using native animals (subspecies *mergens*) from

Honey Lake Valley, Lassen County. Some are known to have escaped into Indian Creek by 1929 (Dixon, 1929, p. 359).

Sierra Valley, Plumas and Sierra Counties.—Present at least since 1934 in the vicinity of Blairsden, Vinton, Loyalton; source unknown.

Coutelenc, Butte County.—Ten pairs obtained from Colorado in 1929 were confined in a pen. Reported to have been taken by predators; none present in 1931 and no sign found on adjacent Little Butte Creek in January, 1936.

Oroville, Butte County.—Reported as present in one place on the Feather River in 1935; sign and animals seen in fair numbers during January, 1936; no evidence of muskrats found either above or below this locality.

McArthur, Fall River Valley, Shasta County.—A muskrat farm was established in 1930 4 miles north of the town, on Mud Lake, by Mount Shasta Fur Farms. The valley contains a network of creeks and canals connected to the Fall and Pit rivers. Muskrat stock from Ohio, Colorado, and North Dakota (according to employees of the farm) was first bred in pens. In 1931, 228 were released into a mesh-wire fenced enclosure and in 1932 others were added to a total of 599 (of these 374 were females). Muskrats were first reported outside the fence in 1933 but later inquiry brought reports of escapes in 1932 and possibly even in 1931. Five trappers employed by the California State Department of Agriculture took 1818 muskrats in May and June 1933, when funds for the work were exhausted; appeal for additional appropriations at a special session of the State Legislature were unavailing. Employees of Shasta County and a local power company took an additional 1148 rats that autumn, 496 of these within the fence. In the winter of 1933–1934, commercial fur trappers and a CWA project accounted for about 1800 more in the Valley. Later trapping produced 4812 muskrats in 1934, and 3476 in 1935 that are of record. Muskrats, presumably from this source, are reported in Hat Creek, a southern tributary of Pit River, some miles to the west. Dams around springs and small levees about fields in the Fall River Valley were perforated by numerous muskrat burrows in 1933.

Redding, Shasta County.—Two animals were trapped adjacent to Sacramento River in 1935; subsequent search in 1936 of Pit River, which connects Fall River Valley with Sacramento River, failed to indicate muskrats in intervening territory.

Shasta Valley, Siskiyou County.—About 1925 or 1926, muskrats were planted above Big Spring near Shasta River in the vicinity of Mayten. By 1931, muskrats had already spread down stream and were causing some damage to small dams on farms; one entered the intake of a water pump which had to be overhauled in consequence! The Shasta River is tributary to the Klamath River.

Surprise Valley, Modoc County.—Two muskrat farms were established, one at Lake City (1926), another north of Fort Bidwell. By 1932 or earlier,

muskrats had escaped to adjacent wet meadows and streams and caused minor difficulty by undermining temporary dams constructed to spread water on the sloping meadows. This area is separated by the Warner Mountains from the headwaters of Pit River.

Details given here, where not otherwise acknowledged, are from field observations by the author, supplemented by personal and written communications from federal, state and county agricultural officials concerned with rodent problems in California. Northern records for 1936 were secured by a trapper-observer employed by the State Department of Agriculture. W. C. Jacobsen, in charge of Rodent Control for the State Department, has aided greatly in the accumulation of records. To him and the other collaborators the author here expresses gratitude for the help rendered.

For many years the California quarantine law has contained a clause prohibiting entry of animals detrimental to horticultural or agricultural interests, and the game laws contain a provision that fur farmers should obtain annual licenses from the Division of Fish and Game; but these two laws were not rigidly enforced with respect to alien vertebrates. The muskrat situation in the Imperial Valley and reports of these animals in Kern County served to focus attention on the potentialities of the species. On May 15, 1929, notice was given by the Division of Fish and Game, at the suggestion of the State Department of Agriculture, that no permits would be granted for muskrat farming west of the Cascade-Sierra Nevada mountain system. Yet in February, 1930, a permit was granted for the Fall River Valley farm, on representation that adequate fencing would enclose the animals. Within 2 years (possibly less) muskrats were scattered over the valley. In 1933, the State Legislature (Chap. 312) incorporated the regulation of 1929 into the California Fish and Game Code (Sec. 1323). This reads as follows:

"It is unlawful to import or transport into, or possess any live muskrat (genus Ondatra) in the region west of the crest of the Cascade-Sierra Nevada mountain system, and west and south of the Tehachapi, Liebre, San Gabriel, San Bernardino, San Jacinto, Cuyamaca, and connected mountains south to the international boundary, or in any water shed tributary to or draining into the Pacific Ocean, except the drainage basin of the Klamath River. It is unlawful to import or transplant live muskrats into any part of California outside said region, except under permit issued by the [California Fish and Game] Commission. A county agricultural commissioner, fish and game deputy, or State plant quarantine officer may enter upon lands or waters where muskrats unlawfully exist, and remove or destroy muskrats thereon or therein."

The principal facts relating to introduction and spread of muskrats in California were brought to the attention of the general and agricultural public in meetings and through newspaper articles and radio broadcasts, without significant result.

In 1937, a bill (Senate 719) was introduced into the California Legislature

proposing Fish and Game District 100 to comprise all inland lakes in Tehama County not having an outlet into any stream. Section 2 of this bill read, "Nothing in this code prohibits the raising of muskrats in the waters in district 100. . . ." The intent was to permit "farm" rearing of muskrats in this special district which is within the prohibited area of Sec. 1323 cited above. The bill failed to become a law.

Agricultural officials of the state and counties are aware of the problems arising from the presence of muskrats in irrigated regions, but, lacking public interest and financial support, no sustained attempt at eradication has been possible. Trappers and furriers consider the new supplies of muskrats advantageous.

LITERATURE CITED

CHAPPELLIER, A. 1930. Les dangers de l'elevage du Rat Musqué. Rev. d'Hist. Nat., Soc. Nationale d'acclimatation de France, vol. 11, pp. 1–25.

——— 1933. La lutte contra le Rat Musqué. France. Ministere de l'Agriculture, Collection de Monographies publiee par L'Institut des Recherches Agronomiques, I, pp. 1–72.

DIXON, J. 1922. Rodents and reclamation in the Imperial Valley [California]. Jour. Mamm., vol. 3, pp. 136–146.

——— 1929. Artificial distribution of fur-bearing mammals. Jour. Mamm., vol. 10, pp. 358–359.

EYERDAM, W. J. 1932. A shipment of muskrats to Kamchatka. Jour. Mamm., vol. 13, pp. 281–282.

HINTON, MARTIN A. C. 1933. Rats and musk rats. Public Works, Roads and Transport Congress (1933). England, 8 pp.

HOLLISTER, N. 1911. A systematic synopsis of the muskrats. North Amer. Fauna, no. 32, 1–47 pp.

MOHR, ERNA. 1933 The muskrat, Ondatra zibethica (Linnaeus), in Europe. Jour. Mamm., vol. 14, pp. 58–63.

MUNRO, T. 1931. Musquash in Scotland. Scottish Nat., no. 189, May–June, 1931, pp. 65–70.

——— 1935. Notes on musk-rats and other animals killed since the inception of the campaign against musk-rats in October, 1932. Scottish Nat., no. 211, Jan.–Feb. 1935, pp. 11–16.

NEWBERRY, J. S. 1857. Report upon the mammals *in* Report upon the zoology of the route [from the Sacramento Valley to the Columbia River]. Pacific R. R. Repts., vol. 6, part 4, pp. 35–72.

POETEREN, N. VAN. 1934. De bisamrat nadert onze grens. Tijdschrift over Plantenziekten, vol. 40, pp. 130–135.

PRITCHARD, A. L. 1934. Was the introduction of the muskrat to Graham Island, Queen Charlotte Islands, unwise? Canadian Field-Nat., vol. 48, p. 103.

PUSTET, A. 1928? Ausbau und Ergebnisse der Bisamrattenbekämpfung in Bayern in den Jahren 1926 und 1927. Arb. aus d. Bayern Landesanstalt f. Pflanzenbau u. Pflanzenschutz, Hft. 6, pp. 1–32.

——— 1933. Die Bekämpfung der Bisamratte in Bayern im Jahre 1932. Praktische Blätter f. Pflanzenbau u. Pflanzenschutz, Jahrgang 11, Hft. 5–6, pp. 124–136.

——— 1936. Die Bekampfung der Bisamratte in Deutschland 1935/36. Nachrichtenblatt den Deutschen Pflanzenschutzendienst, 1936, no. 12; Sonderabdruck, 5 pp.

TOLDT, K., JR. 1929. Die Bisamratte (Fiber zibethicus L.) mit besonderer Berücht-sichtigung ihres Auftretens in Österreich. Arb. d. Reichs-Zentrale f. Pelztier- u. Rauchwaren-Forschung (Leipzig, Arthur Heber & Co.), no. 15, pp. 1–98.

ULBRICH, JOHANNES. 1930. Die Bisamratte, Lebenweise, gang ihrer Ausbreitung in Europa, wirtschaftliche Bedeutung und Bekämpfung. (Dresden, C. Heinrich), 137 pp.

WARWICK, TOM. 1934. The distribution of the muskrat (*Fiber zibethicus*) in the British Isles. Jour. Animal Ecol., vol. 3, pp. 250–267.

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HIBERNATION AND BREEDING OF THE BLACK BEAR

BY MARIUS A. MORSE

During the severe winter of 1935–1936, two "families" of hibernating black bears (*Euarctos americanus*) were discovered in the Cloquet Valley State Forest of northern Minnesota, 32 miles north of Duluth. Careful observations by the writer and a trained CCC field assistant, Otto Kuehne, were made intermittently during the period from January 3 to April 20, 1936.

The first family observed, an adult (sex undetermined) and 3 yearling cubs, was discovered by Mr. Kuehne as he was engaged in carrying out a wild life inventory study on a sample forest area close to CCC Camp S–51. This area had been traversed daily since December 1, 1935. The bears were hibernating in an open black spruce (*Picea mariana*) swamp less than one-quarter mile from a main forest road. Rather than den up, they had selected a distinctly open site on the swamp floor and were protected only by surrounding trees. It is the opinion of the writer that this location would have been their permanent winter quarters had they not been disturbed at a later date.

A second hibernation site, on a highland and only four miles from the other site, was found accidentally on January 8, 1936, by two forest reconnaissance mappers. The den apparently served as a breeding site at a later date.

Weather conditions were extreme during a part of the period during which the two sites were under observation. Extending from January 15 to February 24, 1936, the cold wave experienced in northern Minnesota was the most severe in the history of the Weather Bureau, and temperatures ranged consistently from 0 to −40 degrees Fahrenheit. By January 3 the snow in the forest was approximately 13 inches in depth. Several heavy snowfalls during the remainder of the winter brought the snow depth to a maximum of 32 inches on February 13.

Through the efforts of W. J. Breckenridge, Preparator of the University of Minnesota Natural History Museum, excellent pictures were obtained of the hibernation sites. Actions of the yearling cubs and adult in their second

bed have been recorded in moving pictures taken within 15 feet. The following discussion is an attempt to catalogue the activities of the hibernating bears by means of a narrative presentation of facts as taken from field observations in chronological order.

On January 3, 1936, at 9:42 A.M., with the temperature +22 degrees F., Mr. Kuehne identified the bears as they lay in a "big heap at the base of two trees, a 3 inch black spruce and a 3 inch balsam fir" (*Abies balsamea*). The animals were cuddled so closely together that it was difficult to determine if there were two or more individuals. Two different shades of dark fur were noted. The observation was made at a distance of 10 yards for a period of 20 to 30 minutes. During that time, the largest of the bears opened its eyes, pricked its ears, and looked directly at the observer for several minutes. After changing its position twice, it resumed its sleep. No sign of a bear track could be found in the vicinity and the indication was that the animals had been hibernating for some time. Their bodies were entirely free of snow.

The next day, January 4, at 11:09 A.M., three observers visited the bears in an effort to obtain pictures. The site was approached quietly and the bears appeared to be sound asleep. A light snow that had fallen the night before had partially covered the fur of the animals. Ordinary conversation failed to disturb them, but considerable shouting and whistling awakened the cubs, whose bodies were covering the head of a larger bear. First one and then another cub raised its head, stared at the intruders for several seconds, and then cuddled down again by the adult bear, dark brown in color. Apparently they were not in the least frightened. This continued for several minutes until one of the cubs arose slowly and began to amble off through the light, dry snow. It was followed by a second, and still a third cub, all yearlings. They were of the same size, approximately 2.5 feet in length, but two were light brown while the third was nearly black.

As the cubs moved to a distance of 10 yards, one suddenly turned and began to plod back toward "home". At that moment, seeming to sense the absence of its cubs, the adult bear awoke from its deep slumber and very shakily sat upon its haunches, surveyed the situation—including the observers only 15 yards away—then slowly moved off toward the cubs, joining them and taking the lead. In single file the four bears ran deeper into the swamp and out of sight, the parent traveling with leaps and bounds. It appeared to be well conditioned and over 200 pounds in weight. No attempt was made at pursuit.

The hibernation bed, about four feet in diameter and lined with a few sticks, was merely a shallow depression in the sphagnum moss and Labrador tea (*Ledum groenlandicum*), with no cover other than that provided by the lower limbs of a black spruce tree whose stem was clear of branches for 4 feet above the ground. The tree possessed an unusually large number of branches. There were a few tamarack (*Larix laricina*) snags in the vicinity. The

hibernation site was within 50 yards of the alder-fringed margin of the swamp. Second growth aspen (*Populus tremuloides*) and white birch (*Betula papyrifera*) type, with abundant balsam reproduction and scattered young Norway pines (*Pinus resinosa*), white pines (*Pinus strobus*), and red maples (*Acer rubrum*) surrounds most of the swamp, which is narrow, irregular in outline, and not over 150 acres in area. There is a considerable amount of pin cherry (*Prunus pennsylvanicum*) and lesser amounts of mountain ash (*Sorbus* sp.), black haw (*Viburnum lentago*), and serviceberry (*Amelanchier* sp.) in the near vicinity.

An account of further pertinent field observations, with brief weather notes, follows: January 7, 2:25 P.M. (temperature −10 degrees F. at 11 A.M.; skies clear; no recent precipitation; snow 15 inches deep, and soft). Upon visiting the old hibernation site, which was empty, it was seen that the bears had walked about 60 yards into the swamp, then back to within 10 yards of the old bed, after which they had zig-zagged along the swamp margin through slash and young balsam to a more protected site beneath the overhanging roots of a northern white cedar (*Thuja occidentalis*) windfall, within 200 feet of the highland. The tree had fallen towards the west. As the observer approached the bed, he was met by the adult bear, this time very much awake, only 7 yards away, and peering at him from behind the dense alder stems close to the uprooted cedar. The animal seemed anything but friendly and the observer quickly retreated, with no attempt to view the cubs. As reported by observer Kuehne, "A low, moaning sound seemed to be coming from the sleeping cubs and could be heard distinctly." The new hibernation site was approximately 190 yards distant from the original "bed" and located in an open stand of mixed white cedar, black spruce, and balsam.

January 15, 9:17 A.M. (temperature −15 degrees F. at 8 A.M.; skies clear; 8 inch snowfall January 12–13; snow depth 24 inches). The adult and all three cubs were sleeping soundly. They appeared to be lying in a position much the same as in the original place of hibernation. There was no snow on their bodies. Whether or not the recent heavy snowfall had melted upon contact with the bears' fur coats or had been dislodged by considerable movement, could not be determined.

January 31, 10:40 A.M. (temperature −23 degrees F. at 8 A.M.; skies partly clouded; snow depth 24 inches). The bears were still asleep and there has been little change since January 15.

February 10, 3:20 P.M. (temperature −4 degrees F. at 8 A.M.; partly cloudy; 7 inches of snow fell in last 48 hours; snow depth 30 inches). Observer remained close to hibernation site for 10 minutes, during which time the adult awoke, blinked its eyes as if the bright light hurt them, then sat upon its haunches and looked down at the cubs in a manner suggesting a check on their presence. The animal was shivering, noticeably. A very small amount of snow lay on the bears' bodies.

February 13, 1:30 P.M. (temperature −6 degrees F. at 8 A.M.; partly cloudy; snow depth 32 inches). Hidden in a dense balsam thicket only 1.5 yards from the bed, the observer remained for one hour. One of the brown cubs and the black one respired at the rate of 5 and 4 times per minute, respectively. The respiration rate of the third cub could not be determined, as it was lying partly beneath the adult, whose rate of breathing amounted to an average of 4.5 times per minute. In each instance, the breathing was regular. A full respiration, as described, includes one inhalation and one exhalation. The adult was sleeping with head between its front legs but lifted its head for an instant when one of the cubs began to utter that "low, moaning sound", then went back to sleep again. Although snow had been falling all morning, there was but little of it on their bodies.

February 18, 1:01 P.M. (temperature −26 degrees F. at 8 A.M. and −1 degree F. at 1 P.M.; skies clear; snow settling, depth now only 30 inches). The bears appeared to be getting restless. The adult was wide awake. One cub awakened and crawled over the body of the adult into a new position.

March 8, 3:45 P.M. (temperature +35 degrees F. at 3 P.M.; skies clear; 3 inches of wet snow fell last night). Adult bear was definitely more awake and alert than at any previous observation. The cubs were making the same "low, moaning sound". For the several minutes that the observer remained the sound was continuous. Since the last visit, the bears had dug farther under the cedar roots.

March 19, 3:30 P.M. (temperature +41 degrees F. at 3 P.M.; skies clear; snow melting and condition underfoot slushy). Adult bear wide awake but very unconcerned as two observers watched for a short period of time, mostly unconcealed. The cubs awakened occasionally, blinked their eyes, and resumed sleep, uttering the same peculiar "moaning" noise.

March 26, 1:01 P.M. (temperature +14 degrees F. at 7 A.M. and +35 degrees F. at 3 P.M.; snow depth 24 inches; hard crust has formed). Two of the cubs sat upon their haunches and watched the observer, who was 18 yards distant. No activity was noted on the part of the other two bears. On April 1, with the temperature about the same, the adult bear and one of the cubs was observed in an upright position. In plain sight, the observer seemed not to annoy them in the least. None of the bears seemed as active as they were several weeks ago when milder weather prevailed. No sounds were now being uttered by the hibernating animals.

April 9, 8:10 A.M. (temperature +28 degrees F. at 7 A.M. and +50 degrees by 3 P.M.; skies clear; snow very wet). All four bears were wide awake. As the observer cautiously approached, the animals raised their heads and sniffed the air. For having been confined to a bed 3.5 months, the bears' fur appeared to be unusually fluffy and clean. There was no evidence of any shedding of the winter coat. The bears have extended their front feet out on the snow around the edge of the bed for a distance of about 30 inches. The adult must have sharpened its claws on a dry cedar

root. Evidence of previous "clawing" was revealed by several other marred cedar roots beside the "bed".

April 15, 1:30 P.M. (temperature +39 degrees F. at 2 P.M.; skies partly clouded). The bears were gone from the bed, which now was filled with considerable water. From the evidence available, the animals had moved out April 11 or 12. No tracks leading from the bed could be found. Before leaving the vicinity of the hibernation site, the bears had explored a balsam thicket south of their bed some 15 yards, since numerous tracks were in evidence. A four-inch white cedar had been stripped of its bark on three sides, from the snow line to a height of 18 inches. Most of the bark apparently had been devoured. There were tooth marks on the tree and tracks around the base of it, evidently made in wet snow. The absence of tracks leading directly away from the bed suggested that the bears had moved in the early morning when the snow was hard frozen.

In direct contrast to the first "family" of hibernating bears, the second, as previously mentioned, was denned on highland in young white birch and aspen type, and approximately 200 yards east of a large black spruce swamp. Two observers arrived in the early morning of February 3, 1936, with the temperature −12 degrees F., and found an adult bear very much awake and looking through the mouth of the den, which faced toward the west. The animal's head could not have been much more than two feet below the outer portion of the entrance hole. Lying in a curled position, the bear was seen to bite its leg and raise one hind foot, seemingly in response to itching. It was evident that the bear had been out of the den in the past several days to shake itself, since the snow, as far as 4 feet from the entrance hole, was covered with fine, yellow dust. No tracks were noted at the time, and it is possible that the dust may have resulted from vigorous scratching within.

In the late afternoon of February 22, with the temperature about +20 degrees F. and a light snow falling, the den was visited a second time, on this occasion by a party of six. The entrance had been completely sealed shut as the result of recent heavy snow, but a small hole 8 inches in diameter was carefully opened. The large bear, with head plainly visible, could be seen below. It appeared to be wide awake and did not seem disturbed by the noises and movements outside. At one time, a chunk of snow fell on the bear's nose, but even this did not noticeably disturb the animal. It was impossible, under the circumstances, to determine whether or not the bear was alone in its bed. The presence of newly-born cubs was not suspected.

Not until April 20 was the den visited again. The temperature registered +35 degrees F. and a wet snow was falling. The previous day the temperature had risen to +60 degrees, melting all the snow but that in the swamps and a few scattered patches that remained in sheltered locations on the

highland. The den was full of water and fresh snow had obliterated possible tracks around the entrance. Rough measurements inside the den revealed that it was approximately 2 feet deep, 4 feet wide, and more than 5 feet long. The entrance hole at the top was about 18 inches in diameter. The den probably had originally been used by a fox or wolf and later was enlarged by the bear prior to hibernation. The mound of clay-loam soil under which the den was located measured 4 feet in height, 10 feet in length, and 6 feet in width. It was overgrown with young white birch and was bordered by pin cherry and hazel brush (*Corylus* sp.). Further investigation indicated quite conclusively that the mound was a natural feature of the terrain, since there were similar formations in the near vicinity.

In a final attempt to locate evidence of the bears, which evidently had vacated at least several days before, a "check" on the surrounding highland area was considered advisable. Scarcely had the den been left when three small cubs were found huddled together on the ground beside a fallen white birch stub in open young birch-aspen forest type, and only 65 yards from the den itself. Fresh tracks in the snow indicated that the female bear had just left, probably to forage for food. The cubs were lying on a small piece of birch bark beside the old, rotting stub from which the bark appeared to have been recently stripped. Two cubs were definitely black and a third was brown. All were about the same size, 10 inches in length, and weighing close to 4 pounds each.

The adult bear had not re-appeared during a period of 7 minutes. Several hurried snapshots were taken at close range, but the cubs remained undisturbed, never once uttering a whimper. Only when the observers were 200 yards away did they begin to cry loudly, the sound being much like the cry of a snowshoe rabbit in distress.

On May 26, when the den was visited for the last time, it was noted that the cavity was much reduced in size, a condition resulting from the action of accumulated water on the earthen walls. A large pile of greenish colored bear feces (containing fibers and hairs) near the entrance hole had evidently been overlooked on the previous visit. There remained not a single trace of the bear in the vicinity at this time.

It has been demonstrated rather clearly from the two foregoing instances of black bear hibernation that weather conditions determine largely the time when bears shall leave their hibernation sites, for they seem to move on as soon as their bed becomes a catch-basin for water. As a fair deduction, then, it would seem as though an early spring might be very hard on black bear cubs, as they would be forced to leave the den with their mother when it becomes too wet, and would then possibly be exposed to later unseasonable temperatures.

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A HIBERNATING BLACK BEAR WITH CUBS

By Shaler E. Aldous

A hibernating black bear with cubs was found by a crew of CCC boys 17 miles north and 1 mile east of Grand Marais, Minnesota, on January 29, 1937. The den was shown to the writer on February 3 by Ive Hartzberg, who in addition to being construction foreman in the CCC camp, is a taxidermist. Mr. Hartzberg was then requested to make frequent observations and notes on the bear family until the members should leave the den. Most of the following notes were made by Mr. Hartzberg, who later turned them over to the writer.

The opening to the den faced east, and consisted of about 30 inches of snow. It was somewhat irregular in shape and about 18 inches in diameter. The den proper, not more than 6 inches below the ground, was under the arching roots of a dead white pine snag about 15 inches in diameter and 10 feet high. After the snow had melted and the animals had left the den, the cavity was found to be about 18 inches deep and 3 feet wide, a seemingly small abode for such a large animal during the long period of hibernation.

The mother bear lay on her left side all during the period of observation, for the small dimensions of the den made it impossible for her to stretch or to change position except to turn half around from front to back and vice versa. Such turning was noted on several occasions; sometimes the animal's head faced the opening and at other times the back was exposed. It was noted that during warm periods, about 32 degrees Fahrenheit, the head was exposed, but during colder weather the back faced the opening. Although the quarters were cramped, they had the advantage of being warm.

The bear was in a partial stupor during the first few weeks of observation but gradually showed more signs of life. At no time did she show any indication of nervousness at the presence of spectators. When her head was facing the opening, she looked intermittently at the observers for about 10 seconds and then replaced her head between her front legs.

The den was discovered through the noise made by the young, the variations in which clearly proved the presence of two or more cubs. When the den was first found one of them was exposed to view for a short time. In size it was between a chipmunk and a red squirrel, was black with an ashy hue, blind, and had no fur on its hind paws. The claws had a bright ivory sheen and were still covered by the protective sheaths, which would suggest that the animal was, at the most, only a few days old.

The crying of the young was intermittent, indicating that possibly the mother's teat had been temporarily lost. The mother, while apparently asleep or in a lethargic condition, was always ready to move her legs or adjust her position at the least sound of discomfort from the cubs.

It was early in March that Mr. Hartzberg discovered that the family

comprised three cubs. He described them as follows: "Two were rather masculine looking and slightly larger than the third one, which had a more feminine appearance. The head and neck of the latter was not so massive, the body was more slender, and the frontal region was straight and black. The frontal regions of the two larger ones were slightly curved and of a reddish tinge." He did not have an opportunity to determine accurately the sex of the cubs.

During the week of March 20 to 26, the opening to the den was enlarged to almost double its former size. This appeared to have been done by the cubs, as numerous small claw marks could be seen around the opening. The cubs by this time had grown to the size of a medium-sized woodchuck. The weather had moderated and at almost every visit the mother was found facing the opening. This position gave the cubs, which were now quite playful, much more room to perform their antics. Mr Hartzberg says that the motherly instinct of the old bear was well demonstrated by her patience in permitting the untiring little balls of mischief to use their sharp teeth on her nose, lips, and ears, or wherever else they could bite. Occasionally, when their play became too annoying, she brushed them away from her face.

On several occasions while Mr. Hartzberg was watching the cubs playing in the den, he placed his hand near them, and they smelled of it without showing signs of fear.

The first evidence of the mother bear's leaving the den was noted on March 28, when her tracks showed that she had gone a distance of about 12 feet from the den, and had defecated. The fecal matter was undoubtedly that which had remained in the bowel over winter. It consisted of two stools, each 1.5 inches in diameter and about 6 inches long. The outer layer of about one-eighth inch was firm but not hard, while the inner section was of the texture of cow dung, but more mucilaginous, and was mixed with hair (apparently her own) and numerous old-appearing fragments of jack and Norway pine needles. Before returning to the den, the bear made a light meal of fresh spruce needles from a spruce growing near the opening to the den. Several limbs had been broken off, some of which had been stripped of their needles. The others were piled at the mouth of the den, apparently to be used for a later meal. After a few days these limbs were also stripped of needles. Mr. Hartzberg estimates that it takes about 10 days for the digestive tract to function normally after the long period of dormancy. The cubs apparently did not leave the den during March, as no tracks could be found outside the den during this time.

A visit on April 5, at 2 P.M., found the whole family asleep, but the fresh snow bore tracks showing that both the mother and the cubs had been outside. The weather during this period was mostly cloudy and moderate.

On April 7, the family was still in the den but numerous tracks indicated occasional excursions.

A visit on April 9 revealed that the family had left the den the day before, as icicles were hanging from the top of the cavity. April 8 had been a warm sunny day and the melting apparently had rendered conditions too wet for comfort. Then, too, the growth of the cubs had by this time made the hole relatively small for the family. Fecal deposits found a short distance from the den were composed mostly of spruce needles.

Upon leaving the den the bears had traveled a distance of about 500 feet and there had made a new bed on a south slope, in an angle formed by two large windfalls. The bed was prepared by scooping out the rotted wood of one of the windfalls and scattering it over the snow in the crotch formed by the two trees. Around this a fringe of fresh spruce boughs 2 to 4 inches in diameter had been placed. In tracking the bears to the new bed, great care was exercised, as it was hoped to get another glimpse of the family, but they were gone when the bed was found. The bed, however, was still almost at body heat. This new bed was used until the snow had disappeared sufficiently to leave dry spots in higher places and on south slopes. After the family left the den it was not seen again, but the tracks of the bears were encountered until almost all the snow was gone.

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ADAPTATIONS OF MAMMALS TO HIGH ALTITUDES

By F. G. Hall

The principal advantage of land habitats for animals is a constant and relatively abundant supply of oxygen. Such conditions obtain at sea level, but when animals ascend to higher elevations they encounter surroundings of progressively lower oxygen pressures. Finally they may find the oxygen supply so diminished as to be incompatible with their respiratory needs. Under such circumstances they must be able to make physiological adjustments or retreat. The ability to resist low oxygen pressures, however, seems to vary among different species.

Man has long subjected himself to varying oxygen pressures at various altitudes and in low pressure chambers both for scientific and for economic reasons. Little has been learned regarding other animals, however, especially those forms that naturally live at high altitudes. Consequently it was one of the projects of the International High Altitude Expedition to Chile (Keys, 1935) to undertake certain experiments of a more or less comparative nature, using animals that live in the Andean Cordillera. Some of the results have been reported elsewhere (Hall, Dill, Barron, 1936). The purpose of this paper is to present additional information about the nature of respiratory

functions in mammals that live at rather high elevations in contrast to those that live normally only near sea level.

Materials and methods.—Three species of mammals live in the high Andes, the llama (*Lama glama*), the vicuña (*Lama vicugna*), and the viscacha (*Viscacia viscacia*), were used, in addition to domesticated sheep and rabbits. All experimental animals were transported in a portable "zoo" to the various stations occupied by members of the expedition. Blood samples were taken at each station after a period of acclimatization of one week.

Standard methods of blood analyses were used throughout the experiments. The writer's spectroscopic method has been described elsewhere (Hall, 1933). Sheep, llamas, and vicuña were bled from the femoral artery. Rabbits and viscachas were bled from the left ventricle.

Results.—Perhaps the results can best be presented graphically. Effects of altitude on oxygen saturation of blood of various mammals is shown in Figure 1. It appears that altitude has a lesser effect on the oxygen saturation

TABLE 1

Experimental stations established by the High Altitude Expedition

STATION	PERIOD OF OCCUPATION	BAROMETRIC PRESSURE, MM. HG.	ALTITUDE IN FEET
Chuquicamata	April 8 to June 4	543	9,200
Ollagüe	June 5 to June 13 and June 25 to July 18	489	12,020
Collahuasi (Montt)	June 13 to June 25	429	15,440
Aucanquilcha	June 26 to July 15	401	17,500
Punta de Cerro	June 29 to July 14	356	20,140

of blood of llamas and vicuñas and a greater effect on sheep and rabbits. On the other hand, it can be seen from the writer's results (Figure 2) that more pronounced changes take place in the blood of sheep and rabbits than in that of llamas and vicuñas when these animals are transported to higher altitudes. The oxygen-carrying power of the blood is greatly increased in sheep, rabbits, and human subjects as a result of a more rapid proliferation of red blood cells containing hemoglobin. The increase in number of red blood cells and hemoglobin concentration in blood of llamas and vicuñas is very constant at various altitudes from sea level to 20,000 feet. Since the oxygen capacity of blood from one group of animals showed such a noticeable increase in contrast to that from another group, experiments were made to ascertain whether or not there were differences in the affinity of hemoglobin for oxygen. It was found, as was the case for man (Hall, 1936), that the affinity of hemoglobin for oxygen does not increase appreciably in the individual with changes in altitude. Considerable differences were detected, however, between species.

The results show that the bloods of the vicuñas, llamas, and viscachas possess hemoglobin with a much higher affinity for oxygen than those of rabbits and sheep. For example, the partial pressure of oxygen required to half-saturate hemoglobin at pH 6.8 was 13 mm. for vicuñas, 18 for llamas, and 19 for viscachas, while 26 mm. was required for rabbits and 37 for sheep. It is also interesting to note that under similar conditions, 50 mm. oxygen

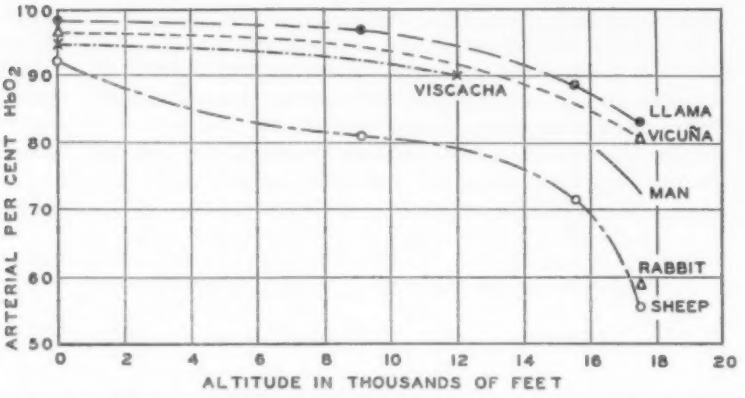

FIG. 1. Graph showing the effects of various altitudes on the saturation of arterial blood with oxygen in different species of mammals.

TABLE 2

Size and concentration of red blood cells of animals after adjustment to an altitude of 9000 ft.

	RED BLOOD CELLS, MILLIONS PER MM^3	RED CELL, VOL. %	AVERAGE VOL. OF 1 CELL, $MM^3 \times 10^{-6}$
Sheep	9.33	28.6	3.35
Llama	12.32	28.2	2.29
Vicuña	14.10	30.1	2.12
Rabbit	6.42	44.8	6.98
Viscacha	7.12	31.8	4.46
Man	5.40	53.0	9.82

pressure is required to half-saturate the hemoglobin of a domestic cat. Cats appear to be unable to live at high altitudes. Dogs, however, possess hemoglobin with a higher affinity for oxygen and are able to endure the oxygen pressure of high altitudes fairly satisfactorily.

The morphology of blood of mammals also presents evidence of adaptation to high altitudes. A large number of very small cells in the vicuña naturally

affords a larger surface area for the diffusion of oxygen. Thus oxygen can be more readily "picked up" in the lungs and more readily "unloaded" to the tissues. The size and concentration of red blood cells for several species is shown in Table 2.

Discussion.—Native mammals of the high plateaus of the Andean Cordillera furnish excellent examples of adaptation to high altitudes. There, where

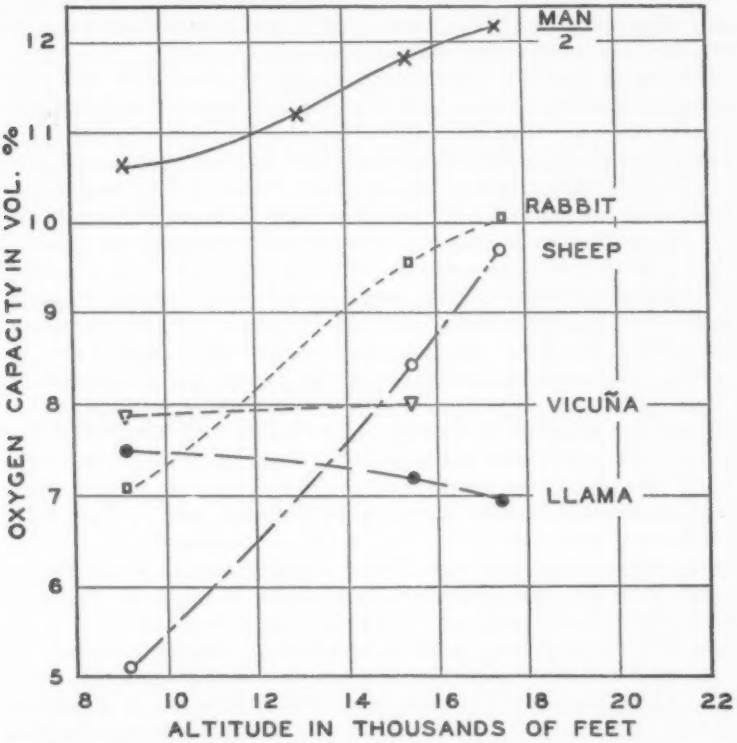

FIG. 2. Graph showing the effects of altitude on the oxygen capacity of bloods of several mammals.

the oxygen pressure is greatly reduced, llamas show remarkable strength and endurance. They have been pack animals for human beings for many centuries, and supply milk for infants, hair for weaving cloth, and meat for the meager diet of adults. Closely related to the llama is the vicuña, another mammal of the camel family. This species is rarely domesticated. It is a strange and interesting experience to see vicuñas in herds of 20 or more individuals running over the almost barren ground of the Bolivian plateau.

One of the thrilling adventures of our expedition was chasing such a herd out onto the desert. We drove two automobiles for some time at a speed of at least 30 miles per hour at an elevation of 15,000 feet without gaining on the herd, and only by circling them were we able to shoot one with a high-powered rifle. A young vicuña was tamed and became the pet of the expedition. It seemed to dislike confinement and got exercise by running and jumping whenever allowed to do so at any altitude. Viscachas seem fairly plentiful in the Andes. They, likewise, live an active life, and seemed little handicapped by lower oxygen pressures.

If the results obtained with the various animals used in the writer's experiments be compared, it is apparent that each species of animal falls into one of the two groups. Animals native to high altitudes seem very well adapted to such conditions and their blood shows little response to changes in elevation. Animals native to regions near sea level must, if they survive, make rather rapid adjustment when moved to high altitudes. Even with such adjustments they are limited to a narrower range of oxygen pressures. It is proposed that those animals that are able to withstand relatively greater differences in altitude be called *eurybaric*, and those capable of enduring relatively lesser differences be called *stenobaric*. To the eurybaric animals belong llamas, vicuñas, viscachas; to stenobaric, sheep, rabbits, cats, and the like. Man occupies a position somewhat intermediate between the two groups.

Altitude is one of the components of the physical environment of animals to which they must either become adapted through long periods of time, or possess potentiality for re-adjustment. Illustrations are offered in this study. Eurybaric animals present a physiological pattern that enables them to meet their respiratory needs, in varying oxygen pressures, without the necessity for re-adjustment. These animals normally live in environments where the oxygen pressure is lower than at sea level. Stenobaric animals normally live near sea level where oxygen needs are more readily met. They do not possess ability to make abrupt changes in altitude with ease, but nevertheless they have the facility for making re-adjustments which enable them partially to overcome this limitation. In all animals, however, oxygen pressures appear to be the limiting factor in ascent to higher altitudes.

LITERATURE CITED

HALL, F. G. 1934. A spectroscopic method for the study of hemoglobin in dilute solutions. Jour. Physiol., vol. 80, pp. 502–507.

——— 1936. The effect of altitude on the affinity of hemoglobin for oxygen. Jour. Biol. Chem., vol. 115, pp. 485–490.

HALL, F. G., D. B. DILL, and E. S. G. BARRON. 1936. Comparative physiology in high altitudes. Jour. Cell. Comp. Physiol., vol. 8, pp. 301–313.

KEYS, A. B. 1936. The physiology of life at high altitudes. Sci. Monthly, vol. 43, pp. 289–312.

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NOTES ON POCKET GOPHERS

By Edward R. Warren

While pocket gophers of various species are distributed over the whole State of Colorado, such special studies as I have made of them have been confined to two species of the genus *Thomomys*, the Colorado or mountain pocket gopher, *Thomomys fossor*, and the Coues pocket gopher, *T. talpoides clusius*. The former species is a mountain animal, ranging from the foothills to above timberline wherever it can find soil in which to work. The other species is more of a plains animal, living, where I know it, below, although close to, the foothills. I do not know of any place where the ranges of the two species overlap.

In my contacts with these animals I have come upon various interesting occurrences that are worthy of description. Like all the pocket gophers, these species have the habit, when the ground is covered with snow, of ejecting the earth from their burrows into tunnels under the snow. When the snow melts, this earth is left as cylinders irregularly distributed over the ground, often over a considerable area. In the mountains where the snow is deep and lies for several months before melting, the ground is sometimes so covered with these cylinders that it seems as though hardly a square foot could have escaped the operations of these miners.

In July, 1935, I found much of this sort of work about 3 miles above the old mining camp of Gothic, Gunnison County. The snow had not been gone from here long enough for these earth cylinders to have disintegrated and collapsed, and the new grass and other vegetation had not yet grown up sufficiently to hide them. Consequently they were a conspicuous feature all about the camp.

All along the road leading to Scofield Pass, nearly 11,000 feet, there was still snow in places, and between these drifts was much gopher work, with many fine examples of these cylinders. At one place an area about 30 feet square was a network of these earthen plugs, and near Emerald Lake was a similar area 30 by 40 feet.

At still another place there was a lot of this work between two fallen logs. One of these logs was 23 feet long, 30 inches in diameter at one end and 24 at the other. The other log was much longer, and 18 inches through at the smaller end. The logs were 3 feet apart at one end and 6 at the other. Much of the space between them was covered by gopher work, which did not appear to extend beneath the logs.

The sight of all this earth on top of the ground gives one a much more forceful impression of the work that these animals do in turning over the soil than does that of the usual mounds, the cylinders usually being much more conspicuous and noticeable. As they are 2 to 3 inches in diameter, sometimes more, the amount of earth thus moved must in the aggregate be very considerable.

Even where the snowfall is light and the snow does not lie for long upon the ground, the gophers do this sort of work. I found much of it near Monument and Beaver creeks, southwest of the town of Monument, El Paso County, in March, 1931, after a comparatively light snowfall of perhaps 6 or 8 inches. March 20 I found a great deal of this work near Monument Creek. One area with these cylinders was 15 feet wide and 33 feet long; another space was 30 feet square, with many cylinders, and a short distance away, along a sloping bank, these evidences of gophers occupied an area 90 feet long and 6 to 10 feet in width.

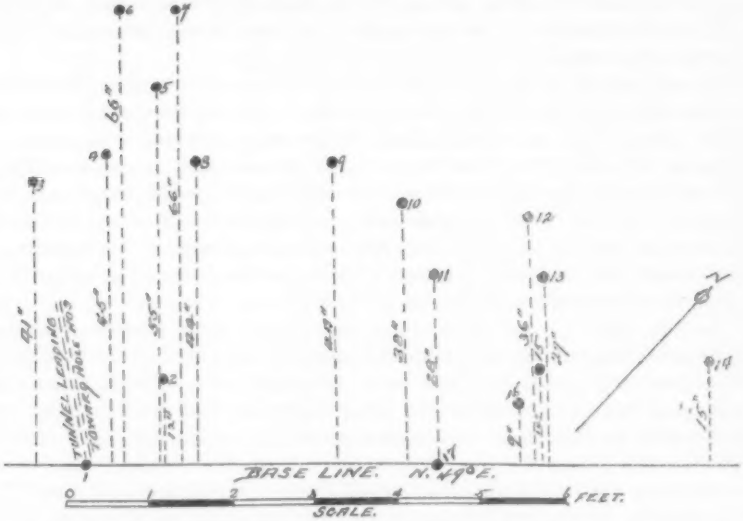

FIG. 1. Plan of gopher working on the Robert's Ranch, the surface holes (black circles) laid out with distances from base line.

The arrangement of these cylinders is haphazard, evidently the result of chance. The miner pushes a load out under the snow a little way from the mouth of a burrow, goes back for another load and pushes that against the end of the first, and continues repeating the process. If the earth goes straight ahead, all right, but it is more likely to bend a little to one side or the other, which is a matter of indifference to the gopher. When work is done at various places in a tunnel and dirt put out at several different openings, the result is the network one often sees.

A few days after I saw the above mentioned work I found a group of the cylinders near Beaver Creek, strung out for 17 feet, with an extreme width of 42 inches, lying along a slope, with one outlying cylinder a little below

the rest. These cylinders were all at least 2 inches in diameter, and many were 2 inches high by 3 across. I made a sketch of this group.

In April, 1932, I found a group of pocket gopher holes on the Roberts Ranch, Monument Creek. There were openings where the animal had come up to the surface. About a month later I revisited the place. Numbering each hole by means of a bit of paper on a stick, I photographed the place. A base line was then laid off and the location of each hole established by means of offsets from this. The length of the base line was a little more than 8 feet, and the greatest distance to any hole, 66 inches. The sketch shows this.

FIG. 2. Earth cylinders pushed out beneath the snow by a pocket gopher near Monument, Colorado. March 20, 1931.

The holes varied in depth from 4 to 18 inches, but only four were less than 10 inches deep. Hole no. 1 dipped downward and extended toward no. 3 for 31 inches but the two did not connect. I dug down 10 inches but could not find the tunnel. I had only a small garden trowel, a tool not strong enough for the work. Every hole had loose earth in it, so that I could not find the tunnels below. I thought that this must have been cold weather work, and that the burrows had been dug below the frost line. Quite likely the openings were made later in order that the animals might come out for food.

A gopher, at least sometimes, will take advantage of an opportunity to dump its load without taking it to the surface. I found an example of this

on Beaver Creek in January, 1931. Here was a vertical cut bank the base of which was 6 feet from the water and 30 inches above it. The bank itself was about 6 feet high. At its foot I noticed a couple of fresh-looking piles of earth that looked as if they had fallen from above, and then I saw a small round hole below the top of the bank and directly above each pile. One hole was 21 inches below the top, and the earth pile below measured 4 feet across the base and 18 inches in height. The other hole was 14 feet upstream and a foot below the top of the bank. The dump here was much smaller than the other, less than 30 inches across and 10 high. Each hole was about 2 inches in diameter, and both slanted upward slightly. On the ground above the bank were gopher mounds, but none of them fresh. The gopher

FIG. 3. The bank where a gopher had dumped excavated earth from holes above. The white rule is 6 feet long.

evidently found it easier to dump below the frost line than to burrow up through the frozen ground.

If the holes in certain cut banks that I have seen were made by pocket gophers—and I do not know what other animal could have made them—the animals go deep at times, for I have seen them 5 feet below the surface, presumably, although not necessarily, made in winter. The erosion of the bank had exposed the holes.

I have made but one attempt at digging out a gopher's tunnel. This was at Crested Butte, Gunnison County, where the species is *Thomomys fossor*. Here, August 22, 1931, I attempted to trace out a system of tunnels. Close to my camp were a number of mounds, and fresh work every day showed

that the animals were living there. Much of the work was on quite level ground, from which the surface fell away in a somewhat gentle slope. Finding some fresh mounds well down on this slope, I began there, following the tunnel up the hill. As an aid to this work I stretched a steel tape from the lowest point up to the level ground, and established the various points along the tunnel by offset measurements from this tape. The ground sloped up 4.5 feet in 44 feet.

Several mounds of earth were along the line of the tunnel, or not far from it. The connection from the latter to a mound usually was plugged with earth. The burrow pursued a rather irregular course, but did not wander very far from the line. It was about 3 inches in diameter, and varied from a few inches to 15 inches below the surface. This refers to the bottom.

At 20 feet from the starting point there was a change in the elevation of the hole, and it rose to a somewhat higher level. At that point I found a salamander (*Ambystoma*) in the tunnel.

The flat was reached 44 feet from the starting point, and here were old mounds and plugged-up holes. Stock had been wandering about, trampling the holes so that it was impossible to trace them farther.

The largest mound made by *Thomomys fossor* that I have ever seen was on the Grand Mesa. It was on a gentle slope, measured 3 by 4 feet, was one foot high at one end and 8 inches at the other. It was all fresh work, a third of the earth evidently having been thrown out on the day when it was examined, August 4, 1931. John Nagel trapped the animal, a rather large individual of the species. He said that the tunnel was a very large one.

July 10 and 11, 1911, I found interesting gopher work by the Ute Pass trail on the eastern slope of Mt. Zirkel, Jackson County. The altitude here is 11,500 feet, and in places by the trail some of last winter's snow still remained. Earth cylinders lay on the ground and on the snow nearby, and abandoned nests were found.

One of these nests was of grass, 14 inches in diameter, resting on the snow, with the entrance hole coming in from the snow on one side. A heap of dung the size of one's fist was in one side or corner, and much more to one side under some stones, as though deposited in a burrow. In the nest was a double handful of pieces of roots of alpine plants.

Just below the summit of the Pass I found three masses of grass about 10 inches in diameter, quite close together, and nearby pieces of the stems of some unidentified plant, 1 to 1.5 inches long. Dung deposits were in several places close by. A nest of grass was found in the snow, having been exposed by the snow melting above it. The nest itself was not as yet above the surface of the snow. It was a foot in diameter, approximately globular, and rested on the snow with the entrance coming in from the snow. No food was stored there.

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A NEW METHOD OF COLLECTING BATS

By Adrey E. Borell

While making a survey of the mammals of the Big Bend area in Brewster County, Texas, I discovered what appears to be a new method of obtaining bats for study purposes.

During the spring of 1937, while encamped at 3500 feet elevation at the east base of Burro Mesa, effort was made to obtain specimens of each species of bat present. During the first two evenings two bats were taken; since camp was in the bottom of a canyon it was soon too dark to shoot. After dark I could see and hear many bats as they came to drink from a large open water tank. I realized that undoubtedly several species that I had not obtained were coming to the tank after dark, and I endeavored to contrive some method of obtaining specimens of the late-flying species.

I had always heard that bats had a remarkable ability to avoid all objects, but watching the free-tailed bats skim the water at a high rate of speed, I wondered if they would be able to avoid fine wires. With a feeling that all of my earlier training was being ignored, I stretched two fine wires across the tank about four inches above the water, and awaited results. A few bats ticked the wires and continued on their way, but shortly a Mexican free-tailed bat hit one of the wires with force and dropped into the water. This one was followed by others, but only Mexican free-tails; the slower flying species avoided the wires or merely touched them.

Some experimentation showed that lack of greater success was due to improper height and spacing of the wires. I found that the majority of bats were coming to the tank in line with the main axis of the canyon, and I therefore placed five wires across the tank at a right angle to the axis of the canyon, and another one parallel to the canyon. The tank was 32 feet in diameter and the cross wires were therefore about five feet apart and were lowered to within one and one-half inches of the water. This height and arrangement of wires brought effective results. Each evening between 8 and 10 P.M. from 20 to 50 bats were obtained. One night I stayed at the tank until 11 P.M. and 93 bats were taken. On April 10, Dr. Karl P. Schmidt and Mr. Leon L. Walters of the Field Museum, Chicago, and Dr. Alfred E. Emerson of the University of Chicago, assisted in the operation of the bat trap. On this evening, by 9:30 P.M., 36 bats of five species were obtained.

During six evenings, 286 bats were trapped, comprising 241 Mexican free-tailed bats, *Tadarida mexicana*: 7 desert pallid bats, *Antrozous pallidus pallidus*; 1 pale brown bat, *Eptesicus fuscus pallidus*; 5 black-nosed bats, *Myotis subulatus melanorhinus*; and 32 canyon bats, *Pipistrellus hesperus maximus*. The large proportion of Mexican free-tailed bats was due to the fact that this species was by far the most abundant in the region, and also to their

rapid flight, which makes them especially susceptible to this method of capture.

Even when the wires were four inches or more above the water, the free-tailed bats often hit with such force that they were thrown into the water, whereas the slow flying forms such as *Antrozous* and *Pipistrellus* could regain their balance and avoid the water.

When wires were one and one-half inches, or less, from the water and from four to five feet apart, practically every free-tailed bat that came to the tank, and a large percentage of the other species, was taken.

In order to keep the wires taut and the proper height above the water, a weight was attached to each end of the wire on the outside of the tank, and another weight fastened to each wire just inside the tank. The outside weights kept the wires taut and allowed for adjustment, and by sliding the inside weights along the wire I was able to keep the wires level and at any desired height above the water. I tried tinned and black wire, sizes no. 24 and 26, and also cotton thread, and could see no difference in effectiveness except that wire is stronger and somewhat easier to adjust.

The bats seemed to pay no attention to the presence of people or lights near the tank, although usually they did not strike the water or wires when a light was held so as to shine directly on the water.

Unfortunately, I had no satisfactory method of marking bats so as to learn definitely whether or not the same individuals returned to the tank on succeeding nights after being trapped. I do know that merely striking a wire did not cause them to forsake the tank. On several occasions I saw bats strike a wire but avoid the water, circle and immediately strike the wire again. In some cases individuals struck wires two or three times before falling into the water.

Upon hitting the wires bats bounced back or dropped into the water. The free-tails then immediately began to swim, usually toward the side of the tank, but occasionally they swam in circles. The free-tails swam rapidly and noisily, often squeaking as they went. The body was held high, propelled by rapid and vigorous strokes of half folded wings. The wings were used in unison, not alternately. The *Pipistrellus* often floated motionless on the water for a few seconds after hitting, then attempted to rise from the water by rapid fanning of the wings. Sometimes they were successful in this endeavor. When unsuccessful in rising, they swam ashore. I saw no bats other than *Pipistrellus* that were able to rise after hitting the water. All species proved to be good swimmers and were able to swim or float for many minutes with no indication of drowning. Some of the free-tails swam completely around the 100-foot circumference of the tank two or three times before I had opportunity for recovering them.

The operator merely walks about the tank and removes the bats as they

swim to the sides. They may then be dropped into a covered box or can containing some corn meal or sawdust, in which the hair soon dries. Heavy forceps greatly facilitates the capture of swimming bats.

This method has the following decided advantages over shooting: It is more effective and economical. Every specimen is in perfect condition and may be kept alive until the next day, which is of decided advantage in hot weather. All bats not needed for specimens may be released uninjured; of the 286 bats trapped not one was killed or injured by the wires. Late flying species usually unobtainable by shooting may be taken by this method. Relative numbers of the various species present, sexes, ages, and breeding condition may be determined. The collector of parasites can examine bats and release them. And much can be learned regarding hours of flight, manner of flight, and frequency of drinking.

In the past, bat banders have had to confine their activities largely to bat caves or roosts. This method presents new possibilities to banders. If bats were captured at several different water holes and banded, one could learn something regarding the local range of different species, range of individuals, whether or not the same bat utilizes various watering places, and other phases of life history.

In areas where there is an abundance of water this method of capture probably will not prove successful, but in the Southwest, where surface water is at a premium, many ranchers have open water tanks or reservoirs at which bats concentrate and that are small enough to permit the stretching of wires. Although I tried this experiment at only one tank, I see no reason why it should not be effective at any small tank or reservoir frequented by bats.

Collectors must either remove the wires or allow them to sink below the surface each evening when terminating operations. Otherwise many bats will be drowned if they are unable to climb from the water. Even if they can climb out, their normal activities will be unnecessarily disturbed if wires are left unattended.

I am indebted to Dr. E. Raymond Hall, Museum of Vertebrate Zoology, Berkeley, California, for identification of the bats listed above.

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DEODORIZING SKUNKS

By Vernon Bailey

Skunks are extremely interesting animals, friendly, easily tamed, affectionate and playful. Their fur is of moderate value and they are useful on the farm as destroyers of mice and insects. The bulk of their food is generally composed of grasshoppers, crickets, caterpillars, beetles and beetle larvae, all injurious insects of which they eat large quantities. They sometimes rob birds' nests and hens' nests found on the ground, and will kill chickens if they are left unprotected. But on the whole they are generally considered far more useful than harmful.

The one strong and valid objection to skunks of all kinds is their powerful, unpleasant and long enduring odor, used as their principal means of defense. This odor is from a pungent, amber-colored liquid secreted by two large glands on the sides of the anus, and discharged by muscular compression through two infolded nipple-like ducts which can be protruded from the anus and from which is ejected the fluid in two fine streams or sprays for a distance of 10 or 12 feet. The skunks seem to have an excellent idea of distance and direction, and generally wait until some real or imaginary enemy is within reach; then with tail thrown upward and forward and a quick twist of the body they are pretty sure to reach their mark with a spatter-gun pattern that will not be forgotten for many a day. On a person's hands or body the odor will remain for about a month, in spite of soap and water, but clothing will often retain the odor for a year or more. To most people it is highly offensive and the mere mention of skunk brings a shudder of aversion.

The fluid is practically harmless, although to a dog that unwisely attacks a skunk it often causes great discomfort, pain and nausea, with the loss of his last meal. Most animals learn to give the right of way to skunks and keep at a respectful distance, well beyond range.

But all of this is merely introductory to the point that I wish to make. A young skunk, preferably from one to two months old, can, by a simple operation, be rendered odorless for the rest of his life, and then introduced to polite society as a gentle pet, or kept in the garden or greenhouse to earn an honest living by destroying insect pests and mice. Also on the fur farm the choicest strains of pure black skunks are more readily handled if permanently deodorized. There is little prospect of ever developing a race of odorless skunks, although I would not dare to say that it could not be done; but in an hour's time a whole family of 6 or 8 young skunks can be rendered unobjectionable for the rest of their lives by a skilful person who knows how. Do not try it unless you have a steady hand, a delicate touch, keen eyesight, and above all, sympathy for animals that will insure gentle treatment.

The equipment required for the simple operation of deoderizing is a hook made from a straightened fish-hook, bass size, set in a handle, the point ground blunt but the barb left sharp, two pairs of small forceps, and a bottle of Zonite for asepsis.

While one person holds the little skunk with thumb and finger of right hand around its neck and left hand over its back, the operator sits with hook in right hand, and with left thumb and finger compresses the anus laterally until the ducts protrude at the edges and are emptied of their fluid. The dull point of the hook must then be delicately inserted into the orifice at the tip of one nipple for a distance of one-half inch in a small animal, and three-quarters of an inch in a larger one. The barb of the hook is pressed sideways into the wall of the cavity and caught securely into the tough, white lining, which is drawn slowly and carefully out through the orifice. When the hook has come clear of the opening it is likely to tear out, and the forceps can then be used to draw out the lining the rest of the way. The membrane may tear at the forceps but by using two pairs, fresh holds will insure its withdrawal and it will then tear or can be cut off at the edge. Now the other side must be treated similarly. If skilfully done there will be not a drop of blood nor any break in the skin or duct, but a little Zonite or some other mild antiseptic should be poured over the anus before the little fellow is replaced in a clean box or basket.

Adult skunks can be treated in the same way, but a larger hook is necessary, and there will be more of the fluid discharged and some danger of getting sprayed if they are not properly handled.

An anaesthetic could be used on large skunks, but with the young the after effects of the anaesthetic might be more disturbing than the operation, and I have never seen any ill effects result. A clean nest of grass should be provided in a roomy box or cage, with food and water, and next day they will have forgotten all about it.

Feeding and caring for young skunks is very simple. While small they should have milk with mush or whole-wheat bread in it, cooked vegetables and ripe fruit, cooked or ground raw meat, with any table scraps they will eat. My little skunk eats any cooked vegetables except onions, at which he draws the line.

When well tamed, carry them out in the woods and fields and let them hunt grasshoppers, crickets, beetles and mice. Turn over logs, boards and stones and let them catch their own game. They like to hunt and play mornings and evenings, and sleep during the middle of the day and the night. In cold climates they hibernate during the coldest months of winter, but in the south they are more or less active throughout the year.

They breed in early spring, but after mating the male takes no further interest in family affairs and might even kill the young if he should find them. The female is a devoted mother and takes the best of care of her large family of pretty babies. When they are two or three weeks old they begin to follow her about to catch grasshoppers and eat ripe blueberries, and a mother skunk with 6 little replicas of herself in one long line of black and white is a fascinating procession.

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A CAPTIVE NEW YORK WEASEL

By John Pearce

Comments from several mammal students who have heard some of the following observations on a specimen of *Mustela noveboracensis noveboracensis* (Emmons), indicate that the facts may be of general interest. This particular weasel, an adult male, was captured in a central New York woodland during field work with Dr. M. T. Townsend for the Roosevelt Wildlife Station. Mr. Wilfred A. Dence, Acting Director of the Station, has kindly allowed these observations to be submitted.

While preparing some small mammal skins at about 10 A.M. on July 29, 1931, a sudden commotion among the leaves in front of the tent attracted my attention. I looked up to see a chipmunk (*Tamias striatus lysteri*) fleeing over the ground not far ahead of a weasel. The chipmunk scampered up a black cherry (*Prunus serotina*) tree about 10 inches in diameter, climbed to a height of 35 or 40 feet, and escaped to a widespreading sugar maple (*Acer saccharum*) by leaping from a side limb across a space perhaps 6 feet wide. Meanwhile the weasel continued the chase into the cherry tree but at a much slower pace. The first rush carried it straight up the trunk for approximately 10 feet, where it hesitated momentarily before continuing. Then, instead of climbing vertically, it made progress by travelling in short ascending spirals around the trunk, scarcely making 3 feet in height for each circuit of the tree. Upon reaching the limb by which the chipmunk escaped, the weasel followed out along this in the same spiral manner. This limb had a diameter of about 4 inches at its base and extended upward at an angle of perhaps 20 degrees above the horizontal. It was much smoother than the scaly-barked trunk. The weasel, finally confronted with the space leaped by its intended prey, stopped, and after looking across several times, abandoned the pursuit. Turning around, it made its way head first almost down to the ground, using the same spiral mode of progress, but at a leisurely pace that enabled me to observe it more closely.

While travelling down the side limb it appeared practically to wrap its sinuous body around the limb. Due to the absence of any apparent uneasiness and the unhurried but not prolonged movements, I concluded that this mode of climbing must be a familiar one. Just why this slower method of climbing was used instead of more direct progress, particularly in the heat of the chase, is not apparent. It is true that arboreal mammals often encircle a tree trunk while climbing it, but many of the more successful ones, as in the genus *Sciurus*, can climb rapidly without doing so. The chipmunk owed its escape to quicker climbing in spite of the well-known preference of this species for staying on the ground. When it reached the tree, the weasel was only a few feet to the rear. It is possible that the explanation lies in the weasel's bounding gait being unsuited to vertical climbing, requiring

a compromise with gravity in the nature of less direct progress. It is worthy of note that another weasel of the same species that I encountered two years later, took refuge in a small sugar maple (in spite of a moderately dense cover of grass and shrubs) and used the same short spirals to ascend, even though it was in great haste. When I shook it down it soon disappeared in the brush.

Seemingly unconcerned over the lost chipmunk, the weasel descended to within 4 feet of the ground before catching sight of me. Then, instead of leaping to the ground as I expected, it scrambled about on the trunk and spiralled up to the crotch made by the first side limb. It remained there for some time, watching intently, tail wrapped part way around the side limb as though for support. When I disturbed it by rapping on the tree with an axe, it went higher, going finally to a very small crotch near the end of the limb used by the chipmunk in escaping. Despite a rapidly rising wind the weasel attempted to settle down, although the branches of the crotch looked no more than one-quarter inch thick. Before a short lull in the wind enabled it to return to better footing, it was shaken and whipped about so violently that I wondered at the strength with which it maintained its grip. Later, in captivity, the latent strength in its legs and feet was often observed. Having regained a secure foothold, the animal paused awhile and finally came down once more to the first crotch in the tree.

A thunder storm broke out a few minutes later, with a heavy downpour of rain. This turn of events greatly distressed the weasel, and after glancing at me a few times it climbed out on a side branch, this time going to the very end. It went so far that the small branches bent sharply with its weight. It hung there for some time, but there was no longer any chance for it to regain a firmer footing. At last the whipping branches and the pelting rain increased until the weasel's desperate hold was broken. Hoping to procure the animal alive, I had secured an insect net and stood below awaiting developments. From beneath, the animal presented a striking picture, falling dorsal side up with legs spread wide after the manner of a flying squirrel. It hit the rim of the net, falling to the ground inert. By the time it had recovered, a matter of a minute or less, it was safely enclosed in a small wire mouse cage. During the fall, or upon reaching the ground and being covered by the net, the weasel emitted a discharge of scent that clung to one portion of the rim for days. The act of scenting apparently can be accomplished with amazing speed, or it is involuntary under certain conditions.

Upon regaining consciousness, the weasel became very restless until the cage was darkened with a burlap sack. When this was removed half an hour later, anger seemed to have replaced restlessness, for the captive exhibited marked viciousness, snapping at any object brought near the cage. A loud throaty squeak, as well as the characteristic hissing noted by Svihla

(1931) and Hamilton (1933) under similar circumstances, was heard at this time.

A small piece of skinned mouse (*Peromyscus*) offered him was greedily consumed. When I presented the remainder of the decapitated mouse, he leaped upon and bit savagely at the neck and forequarters. Suddenly leaving it, he made his first determined effort to escape, biting at the wire and trying to force an exit at the corners of the cage. During these attempts, the animal presented a remarkable picture of intensified ferocity. The efforts to escape ceased as abruptly as they began, and the weasel's attention again was given to the mouse, which was speedily devoured. Thus natural food was eaten within 45 minutes after a shock resulting in a short period of insensibility, and in spite of unnatural confinement in a cage only about 12 x 10 x 8 inches. Although unusual hunger may have been the motivation, the glossy fur indicated excellent physical condition. Nothing abnormal whatever was noticed excepting the presence of about a dozen ticks, several of which were fastened about the head. One, approximately one-quarter inch wide, was located on the upper lid of the left eye. Either it caused less irritation than might be supposed or the weasel was accustomed to the parasite, for during the several days before it disappeared along with the others, no effort to dislodge it was observed.

As a captive, this animal proved to be extremely interesting. Contrary to the individuals described by some writers, it was fairly active during the day. Purposely delayed feeding (until noon or after) may have encouraged such activity, but it will be remembered that it was taken in the middle of the forenoon. During the remaining 5 weeks spent in the field, it fared very well in a wire cage about 5 x 3 x 2.5 feet placed in an airy spot where the sunshine came through the tree canopy just enough to keep the cage dappled with patches of light and shadow for several hours each day. A strong shaft of sunlight did not reach the cage at any time. Hamilton (1933) also found that weasels stand captivity well in somewhat similar locations.

Three to five small mammals were regularly consumed by the weasel each day. No discernible preference was shown for *Peromyscus*, *Evotomys*, *Napaeozapus*, *Sorex*, *Blarina*, or *Tamias*. All 6 were fed together or in varying combinations. Close attention was given to this point, especially when either of the shrews was offered. Shrews were habitually accepted along with the mice. On the day following his capture a piece of pig liver in fresh condition was refused by the weasel in favor of a mouse. After finishing the mouse, however, the liver was eaten. Feeding on the small mammals ordinarily began at their heads. If these were missing, the abdomens were usually chosen first. Both heads and abdomens were particularly attractive to him. If a mouse were suspended from the top of the cage he would manouver it about until able to feed on one of these parts,

even though the effort required him to hang by his toes and 24 hours had elapsed since the last feeding. When several mice were dropped into the cage at one time he usually pounced on one at a time and leaped up to the nest box with it in his mouth. I believe he generally ate them shortly afterward, for as Nichols and Nichols (1935) also pointed out, this caching habit did not result in a fouled nest. Perhaps the weasel's habit of eating all the mouse was one reason for the nest remaining clean. Svihla (1931) reported on a weasel that carried bones and skin to the same corner used for defecation. There probably is individual variation in habits. This particular animal usually ate all parts, including skull, feet and tails of full grown *Microtus* and *Napaeozapus*, even when other mice were piled beside it. Ground beef, if freshly cut and quite lean, was accepted in lieu of mice when the animal was removed to the Roosevelt Station laboratory. In this connection I overlooked the possibilities of a more varied diet. Several writers, particularly Hamilton (1933), mention a large variety of natural and artificial foods on which this species will feed and thrive.

Burrowing seemed to be a familiar activity. The weasel made many temporary burrows through the 6-inch layer of compacted leaf litter covering the cage floor. A favorite habit was to lie for half an hour or more at the entrance to one of these burrows with only the head showing. These were the longest periods of inaction other than those spent resting in the nest box. He did not sleep when lying thus at the mouth of a burrow, but lay watching proceedings about the camp. Each new sound, shadow or odor received his immediate attention. Complete relaxation seemed absolutely foreign to his nature. One use of the burrows was rather interesting. Occasionally, instead of pouncing on an odd mouse dropped into the cage, he would deliberately burrow under the leaves from his position to where the mouse lay. The significance of this procedure was never quite plain. Those who have followed weasel tracks over snow-covered fields where mice were abundant have very likely seen evidence of a weasel burrowing for prey, but in such case live mice are sought. I have never seen instances where weasels have approached bait, carcasses or camp refuse by tunneling, so possibly the burrowing in the cage was not entirely a natural habit.

Following defecation, the anal region was dragged over the leaves for a distance of 6 to 12 inches. This was accomplished by stiffening the hind legs, toes pointed forward, and dragging the body along with the forefeet. Incidentally, he did not always use the same place to void excrement, but did use one place for several days before choosing another. The new location was as likely as not to be the corner holding the drinking jar. Removal of accumulated feces did not appear to affect his continued use of a corner in one way or the other.

Water seemed to please him. Besides drinking frequently, he appeared to enjoy splashing. After drinking his fill, he often thrust his nose to the

bottom of the jar, then withdrew his head rapidly with much sputtering, repeating this action until the jar was empty. If a stream of water were poured into the cage he came out of his box instantly, to dash back and forth through the falling stream.

Playing with a mouse trap for many minutes at a time was another unexpected habit of this animal. The trap was of the standard wooden base, guillotine type, and made a constant rattle as he shook, tossed and rolled it about. He eventually chewed off a fair portion of the wooden base. Whether the chewing was done to satisfy some craving or simply for the noise caused by the loose parts of the trap is not clear. It may well be that many otherwise unexplainable habits in captivity are due to *ennui* of the captive. While this individual did not spend much time in the restless "pacing" so often seen in caged animals, it is very likely that it became greatly bored, in view of the extremely active life that weasels lead in the wild.

Another unexplained action, which though not a habit, was of interest since it indicated a greater dependence upon sight than upon the powers of scent. Shortly after being placed in the larger cage, a tuft of absorbent cotton hanging from the next box caught his eye. In an instant he had leaped up, pulled the cotton to the floor, bit into it savagely, and rolled with it as with a live mouse. It took several moments, to all appearances, for him to realize that the cotton was not prey. Yet it had been placed in the box fresh from the roll with little or no scent of flesh on it.

Opportunities were numerous for observing the tenacious strength of a weasel's toes and claws. The delicate appearance of the feet of this animal was deceptive, for they possessed in full measure the same wiry strength that is characteristic of the entire body. For example, he would spring from the floor of the cage, twist in midair to land hanging upside down from the roof, and stay there without moving while he ate a piece of mouse held in my fingers. On one occasion, when his leap left him swinging by the forefeet, I was astonished to note that only one toe on one foot and two on the other were supporting him. This position was maintained without change for more than 3 minutes. He once hung by all four feet from the top for more than 5 minutes without moving his feet. As a weasel's feet are not especially adapted to grasping prey, this surprising strength should be a decided aid in clutching a victim while rolling with it in attempting to use the teeth. Miller (1931) pointed out the advantage of the elongated body in subduing prey during such rolling tactics. To his thought that the body is all important, however, it may well be pointed out that the small feet have tenacity enough to be useful also.

The smooth precision and nicety of judgment with which the weasel leaped from cage floor to nest box never failed to arouse my admiration. To make an entrance to this box" on the fly" required a slight sidewise twist of head and body. Yet, during the many times that I watched him carry

mice through the opening, he never once bungled his entrance. In fact, the speed with which he left the floor, entered the box, deposited the mouse and thrust his head out of the opening after turning around within the small space, always seemed incredible to me. A favorite exercise involved leaping to a small stick about three-eighths inch in diameter. This stick had been pushed through the mesh across the cage a few inches less than two feet from the floor, and was very smooth. Although he leaped for this stick from all manner of twisted positions, from top, sides and bottom of the cage, he neither under- nor over-estimated his distance at any time. Upon reaching the stick he seemed to attain his balance instantly, almost without effort. It is not surprising that these highly successful little carnivores should exhibit such splendid muscular control, for agility is a part of their daily routine, but it is something to marvel at, nonetheless.

During early September this animal was placed on exhibition at the New York State Fair. Crowds of people filing past had little or no adverse effect, but the prevailing hot weather caused him to lose his characteristic alertness. The cool hours of night and morning found him much livelier. In all he lived 7 weeks. It appears that his death later in the month was caused by the laboratory being inadvertently overheated during one week end.

LITERATURE CITED

HAMILTON, W. J., JR. 1933. The weasels of New York. Amer. Midland Nat., vol. 14, pp. 289–344.

MILLER, FREDERIC W. 1931. A feeding habit of the long-tailed weasel. Jour. Mamm., vol. 12, p. 164.

NICHOLS, D. G., and J. T. NICHOLS. 1935. Notes on the New York weasel (Mustela noveboracensis). Jour. Mamm., vol. 16 pp. 297–299.

SETON, ERNEST T. 1929. Lives of Game Animals. Vol. 2, pt. 2.

SVIHLA, ARTHUR. 1931. Habits of New York weasel in captivity. Jour. Mamm., vol. 12, pp. 67–68.

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NOTES ON THE BREEDING OF SOME CRICETIDAE IN ONTARIO

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The results presented in these notes are derived from regions somewhat distant from most of those that have furnished reports on similar subjects. They refer to conditions among wild subjects, while a majority of the published data concern breeding in captivity. It therefore seems worth while to put them on record in the hope that they may prove to be useful to others.

The material was gathered in the course of several seasons' collecting in connection with studies on the populations of small mammals in Ontario. It includes the forms *Peromyscus maniculatus gracilis* from more northerly areas, Temagami and the Algonquin Park, *Peromyscus leucopus noveboracensis* from southern Ontario, near Toronto, *Clethrionomys gapperi gapperi* from the same areas as *P.m.gracilis*, and *Microtus pennsylvanicus pennsylvanicus* from all areas investigated; also, though in much smaller numbers, *Microtus chrotorrhinus chrotorrhinus* from Temagami and *Synaptomys cooperi cooperi* from all areas.

The data relate to the following details: Number of young in a litter; dates of onset and end of breeding, and its intensity; dates of appearance of first young in spring and of the first pregnancy of young females; and color-phases in *Peromyscus*. These items cannot, however, be given in their entirety for all species, since exigencies of collecting and other duties made it impossible completely to follow the season's activities in all areas.

Number of young in a litter.—The figures are compiled from records of pregnant uteri, and the results are given as follows.

TABLE 1

SPECIES	NO. OF LITTERS	MEAN NO. OF YOUNG	EXTREMES
P.m. gracilis	50	5.38 ±0.13	2–8
P.l. noveboracensis	50	5.04 ±0.08	3–7
S.c. cooperi	9	3.20 ±0.19	2–5
C.g. gapperi	49	5.47 ±0.13	3–8
M.p. pennsylvanicus from the north	23	4.35 ±0.13	3–7
M.p. pennsylvanicus from the south	18	5.83 ±0.29	3–9
M.p. pennsylvanicus all sources	41	5.00 ±0.17	3–9
M.c. chrotorrhinus	9	3.56 ±0.19	2–5

Peromyscus l. noveboracensis. Svihla (1932), working with 53 litters, found the mean number of young to be 4.36, or 0.68 less than my figures. This difference probably is significant. Assuming that it is, there are three possible explanations: (1) the effects of captivity on Svihla's laboratory stock (Svihla himself mentioned this possibility), (2) geographical separation of his material from mine, and (3) difference in methods of obtaining results

(Svihla's from numbers of young born, mine from counts of uterine embryos). I am inclined to discount the last suggestion, since I have found in my series only 4 uteri in which embryos were degenerating, and in each of these only one embryo, a number that does not affect the comparison. As between the other two possibilities, there do not seem to be available sufficient data to permit a decision.

Synaptomys c. cooperi. Howell (1927) gave litter numbers as 4 to 6 for the genus; Linsdale (1927) reported two litters of 4 and 5 respectively. Since these figures are from wild specimens it seems likely that the lower mean litter size in Ontario is an expression of some climatic or geographical effect.

Clethrionomys g. gapperi. Svihla (1929), on the basis of 6 litters born in captivity, gave the mean number of young as 4.16, but the number of cases is too small for useful comparison. Criddle (1932) noted that the average litter size of *Clethrionomys g. loringi* in southern Manitoba is about 4, but he did not state the number of individuals examined.

The marked difference in the sizes of litters of *Clethrionomys* and *Synaptomys* is noteworthy. The average weight of the females is the same, and in Temagami the two species occupy much the same territories, often being taken in close proximity. This comparatively low productivity may be one of the factors that determine the relative scarcity of *Synaptomys.*

Microtus p. pennsylvanicus. The mean number of young in a litter is shown separately for northern and southern samples because of the very marked difference. The southern litters all came from the environs of Toronto; the northern from several sites in the forest region 200 to 300 miles farther north and at an altitude higher by some 500 feet. The difference is, on face value, significant, but I feel it would be well to reserve judgment until a larger series of examples has accumulated, even though there is fragmentary evidence that in other species also there may be a reduction in litter size northward.

The difference in the sizes of litters of *M. p. pennsylvanicus* and of *M. c. chrotorrhinus* is noteworthy. *Chrotorrhinus* averages about 4 grams lighter than *pennsylvanicus,* and in the Temagami region the two species occur in about equal numbers over a period of years, the relative scarcity of *pennsylvanicus* probably being due to the scarcity of appropriate sites in this forest region. *Chrotorrhinus* appears invariably to be associated with loose rocks, overgrown or otherwise, and as far as my experience goes, it is not overlapped by *pennsylvanicus,* even when they inhabit adjoining sites.

Onset, intensity, and duration of breeding.—Information is available respecting the beginning and end of the breeding season of *P. l. noveboracensis* and *M. p. pennsylvanicus* in southern Ontario, and the breeding intensity of *P. m. gracilis* and *C. g. gapperi* in more northern areas.

Peromyscus l. noveboracensis. Of 7 females taken on March 10, 1935,

and 11 taken on March 17, none were pregnant. Fourteen males examined on the latter date had testes ranging in size from 7 to 10 millimeters in major diameter. On April 7, the next date on which specimens were taken, 5 females were all pregnant, the fetuses in 2 being about 15 mm. long, measured as they lay in the uterus. From then until May 12, week-end catches of various numbers revealed every female to be pregnant. A week later the incidence of pregnancies had dropped to 80 per cent, a level held until June 2, when observations were interrupted by work in another area. When

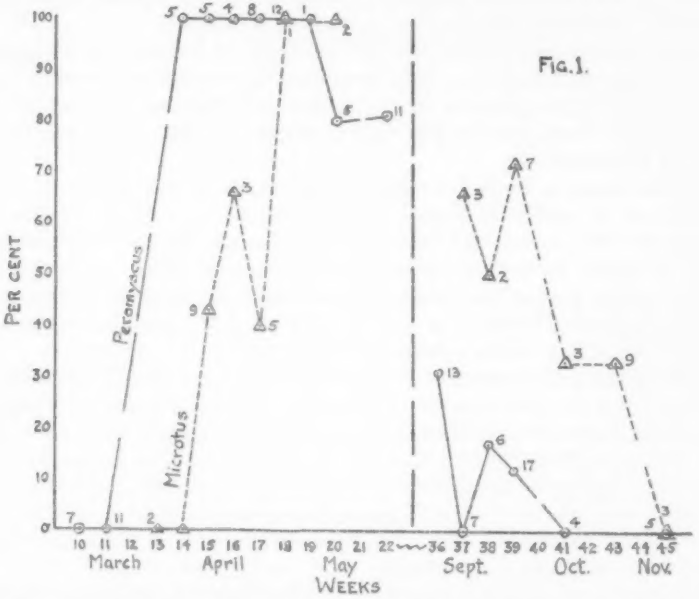

Fig. 1. Onset and end of breeding in *Peromyscus l. noveboracensus* and *Microtus p. pennsylvanicus* near Toronto. Abscissae are weeks of the year numbered serially; ordinates are numbers of pregnant females expressed as percentages of the total number of females captured at the times in question.

observations were resumed on September 8, 31 per cent of females were pregnant; this figure dropped rather irregularly to zero on October 13, and after this date no reproductive activity was found.

These results are presented graphically in Figure 1, where observations for *Peromyscus* are indicated by circles. The figures beside the circles give the number of observations at the point in the curve; they clearly are too few to be conclusive. But the curve is consistent and is given for what it may prove to be worth.

It was, unfortunately, not possible to renew observations in 1936, as the species had become almost too scarce to trap.

Microtus p. pennsylvanicus. The results for this form in the same area as for *Peromyscus* are given in Figure 1, where they are indicated by triangles. The relevant figures are fewer, but the resulting curve is similar to that for *Peromyscus*, although it shows two important differences: (1) *Microtus* starts to breed later than *Peromyscus*, and (2) it continues to breed later. It is possible, and indeed is to be expected from Bailey's (1924) observations, that a high percentage of pregnancies is maintained throughout the summer months. No gravid females were taken after October 27.

Some figures are available for the cessation of breeding in Temagami and in Algonquin Park. At both these stations breeding activities of *Peromyscus m. gracilis* terminate by the beginning of September; a few gravid females have been taken in that month, but the number is less than 10 per cent of those captured.

Clethrionomys g. gapperi continues breeding later than *Peromyscus* and as late as the middle of September about 30 per cent of the females are pregnant. This agrees with Criddle's (1932) remarks on the breeding habits of *C. g. loringi* in southern Manitoba. It appears, indeed, as though the picture of the close of the reproductive season of the Temagami *Peromyscus* and *Clethrionomys* would, if it could be followed to its close, be very similar to that of the two southern forms just discussed.

The intensity of breeding of *P. m. gracilis* and *C. g. gapperi* in Temagami is shown by the lower curves in Figure 2. The percentage of pregnant females is plotted by fortnights, and the figures by each plotted point record the total number of females involved at that point. The curves give the result of combining the data for the summers of 1930 to 1936, excluding 1932, in which no trapping was done. The total figures are rather small, but since they are the product of a number of years and are in themselves consistent, the results are taken as significant.

Peromyscus m. gracilis. The drop in the curve for this species during June and July may be explained by assuming that practically all females become pregnant at the beginning of the breeding season (as has been shown to occur in *P. l. noveboracensis*), and, after producing a litter or two, gradually and in varying degrees pause in the manner described by McNair (1931) for *P. m. bairdi* and *P. l. noveboracensis.*

The well-marked rise in the latter part of July is probably caused by the attainment of breeding age by the first brood of young of the current year. It was noted above that spring young of *P. l. noveboracensis* near Toronto were carrying 14 mm. embryos on June 2, and thus were about to become a significant addition to the breeding population. Temagami is phenologically about 5 weeks later than Toronto; and if we may assume similarity of habits for *P. m. gracilis* and *P. l. noveboracensis*—as seems justified by

Svihla's (1932) work—this rise agrees well with the expectation that spring young would begin to contribute their quota during July.

This interpretation is confirmed by the data exhibited in the upper curve; it shows the percentage of mature females in the total female population, maturity (ability to reproduce) being set at 150 mm. total length, since this is the size of the smallest pregnant female yet taken. The curve shows a well-marked rise in the percentage of females capable of reproducing just before the rise in breeding intensity. The decrease during August, in spite

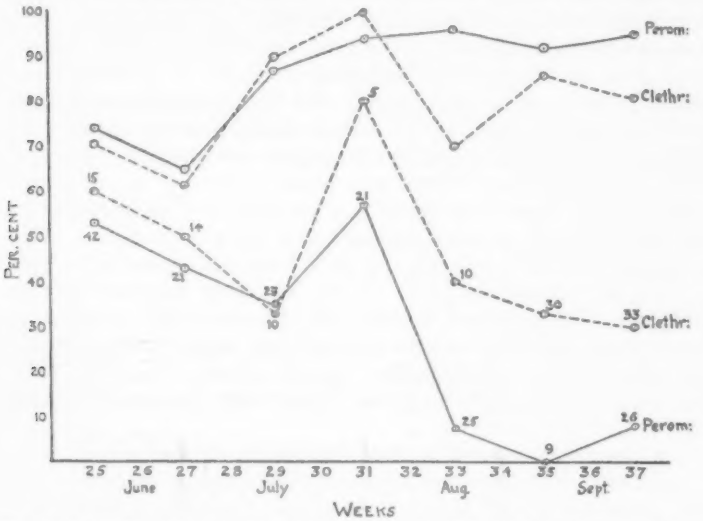

FIG. 2. Intensity of breeding in *Peromyscus m. gracilis* and *Clethrionomys g. gapperi* in Temagami from June to September. Abscissae, weeks of the year numbered serially; ordinates for the lower curves, the number of pregnant females expressed as percentages of the total number of females captured; for the upper curves, the number of mature females expressed as percentages of the total number of females captured. Curves smoothed to fortnights.

of the persistently high percentage of mature females, may be explained in the same way as the June drop.

Clethrionomys g. gapperi. Females of this species are considered to be mature when they reach a total length of about 120 mm., this being approximately the smallest size at which they have been found pregnant. The nature of the curves renders it necessary to assume that this animal has reproductive habits similar to those of *Peromyscus m. gracilis* in the same area. This assumption is not at variance with Svihla's (1929) account of the breeding habits of captive red-backed mice.

Comparison of the breeding intensity curves of the two species raises an interesting point. *Clethrionomys* nearly always constitutes a considerably smaller proportion of the total catch than *Peromyscus*; its average litter size is insignificantly larger than that of *Peromyscus* (5.42: 5.23); it continues breeding later in the season; and its intensity curve is nearly continuously above that of *Peromyscus*. This suggests the question of what controls their relative numbers; possibly the more diurnal habits of *Clethrionomys* with their (assumed) greater risks may be one factor.

McNair (1931) gave curves for the breeding intensity of *Peromyscus*, presumably *P. l. noveboracensis*, at Lawrence, Kansas, under laboratory conditions for the whole year, and among animals taken wild for all months except June to August. My incomplete curve for *P. l. noveboracensis* in Figure 2 appears as though it might, with the missing 3 months supplied, be similar to his laboratory curve, allowance being made for the much shorter breeding season outdoors even at the southern border of the Upper Austral Zone.

The curve in Figure 1 for intensity of breeding in *P. m. gracilis* in Temagami does not seem to compare closely with either of McNair's. The two peaks in his wild curve, separated by about 5 months, are not to be explained on the grounds suggested above for the June–July drop and July rise in Temagami. The difference between the climate of the Canadian Zone, where ice normally leaves the lakes in the first week of May and the first snow falls at latest in mid-October, and the climate of the Upper Austral Zone, seems great enough to produce considerable divergences in breeding behavior.

First appearance of young in traps.—Under this heading the figures given for both species of *Peromyscus* and for *Clethrionomys* probably represent in fair degree the actual conditions, since for *P. l. noveboracensis* they include the earlier part of the breeding season, and, for *P. m. gracilis* and *Clethrionomys*, extend through the greater part of the summer. Possibly this statement applies also to *Microtus*, for which the data, taking all areas together, include the whole breeding season. The results for the remaining two species are certainly open to revision as further data accumulate.

Peromyscus l. noveboracensis. The smallest specimen, of 153 males and 112 females, had a total length of 132 mm.; and both a male and a female of this length are on my records. The smallest pregnant female was 151 mm. in total length. Near Toronto in the spring of 1935, the earliest date of capture of an animal born in the current year was May 12, or 5 weeks after the capture of the earliest pregnant female on April 7. This specimen was 150 mm. long and hence presumably had been coming into the open for several days.

The first of the current year's young to be found pregnant were two on June 2. Both were in the immature gray pelage, and in both the fetuses were about 14 mm. long.

The dates just given suggest that under the conditions of these observations, young may mate at about 6 weeks of age. McNair (1931) stated that young may begin to breed at the age of two and one-half months, but it is not clear whether he meant that they first copulate at this age or first give birth to young; if the former his figures fit with the implications of my dates.

Peromyscus m. gracilis. The smallest of 182 males had a total length of 109 mm., the smallest of 164 females, 116 mm. The smallest pregnant female so far recorded had a length of 151 mm.

My figures give an ascending, although not very smooth, curve for the percentage of pregnant females in successively larger size classes, lumping together catches for the whole summer. The total percentage of pregnant females is 28.48.

Clethrionomys g. gapperi. The smallest of 149 males had a total length of 87 mm., and the smallest of 101 females a length of 91 mm. The smallest pregnant female was 116 mm. in total length, and, as in *P. m. gracilis*, the percentage of pregnant females grows with increasing size. The total

TABLE 2

COLOR	P.L. NOVEBORACENSIS		P.M. GRACILIS	
	No.	Mean	No.	Mean
Gray	13	140.38 ±1.49	63	147.53 ±1.10
Gray-brown	5	152.00 ±3.39	88	163.012 ±0.51
Brown-gray	27	155.18 ±0.69	113	167.74 ±0.43
Adult	157	167.23 ±0.45	87	176.67 ±0.66

percentage of pregnant females for the whole catch of the summer months is 46.59.

Microtus p. pennsylvanicus. The smallest of 90 males recorded had a total length of 105 mm., the smallest of 74 females, a length of 112.5 mm. The smallest of 37 pregnant females was 141 mm. in length, and the earliest date on which a pregnant female is recorded in my notes is April 11, near Toronto. This species, like the two foregoing, shows an increasing percentage of pregnancies in increasing size classes. The total percentage of females pregnant through the breeding season is 63.76.

The increasing incidence of pregnancy with increase of size, and therefore of age, in the 3 species just discussed may be an important factor in analyzing recovery in a population that has undergone marked reductions in numbers, for it implies that a population increases more rapidly in proportion to its numbers as the ratio of old to young individuals increases.

Microtus c. chrotorrhinus. The smallest of 13 males had a total length of 110.5 mm., the smallest of 15 females, 109 mm. The smallest of 9 pregnant females recorded was 152 mm. long.

Synaptomys c. cooperi. The smallest of 22 males was 88.5 mm. long, the

smallest of 16 females, 81 mm. The smallest of 9 pregnant females examined was 103.5 mm. long.

Pelage changes.—Frequent references to immature, adolescent, and adult pelages in the literature give some interest to the sizes at which changes in pelage occur, and data are available in the present material for a general statement for wild *P. l. noveboracensis* and *P. m. gracilis*.

It is possible to distinguish 4 phases fairly easily: (1) pure gray; (2) gray-brown, in which the original gray still predominates, but is becoming suffused with brown; (3) brown-gray, in which the brown tint has so increased that it dominates the gray; and (4) adult brown. The border lines naturally are vague and thus there is some uncertainty in a number of the determinations, but not enough to invalidate the main results.

There may be a wide range of size within which each color-phase may occur, and there is much overlapping of adjacent ranges.

There are small differences between the average total lengths of the males and females for each color-phase, but it is not clear that these are significant in the present material. The measurements for males and females therefore are considered together and are given in Table 2.

In this statement it is clear that no account has been taken of possible factors influencing pelage changes, such as gestation and season; it is merely a summary of observed cases.

In conclusion: Discussion of the results here presented has been deliberately brief, since the time is not yet ripe for generalizations. It is clear that many more accounts, more fully worked out and from as many localities as possible, are needed before even a fairly accurate comparative picture can be made of the breeding habits of our common Cricetidae.

LITERATURE CITED

BAILEY, V. 1924. Breeding, feeding and other habits of meadow mice (*Microtus*). Jour. Agric. Res., Washington, vol. 27, pp. 523–538.

CRIDDLE, S. 1932. The red-backed vole (*Clethrionomys gapperi loringi* Bailey) in southern Manitoba. Canadian Field-Nat., vol. 46, pp. 178–181.

HOWELL, A. B. 1927. Revision of the American lemming mice (Genus *Synaptomys*). North Amer. Fauna, no. 50.

LINSDALE, J. 1927. Notes on the life-cycle of *Synaptomys*. Jour. Mamm., vol. 8, pp. 51–54.

MCNAIR, G. T. 1931. The deermouse (*Peromyscus*), a valuable laboratory animal. Jour. Mamm., vol. 12, pp. 48–52.

SETON, E. T. 1920. Notes on the breeding of captive deermice. Jour. Mamm., vol. 1, pp. 135–138.

SVIHLA, A. 1929. Breeding habits and young of the red-backed mouse, *Evotomys*. Papers Michigan Acad. Sci., Arts & Letters, vol. 9, pp. 485–490.

———1932. A comparative life history study of the mice of the genus *Peromyscus*. Univ. Michigan Mus. Zool. Misc. Publ., no. 24, pp. 39.

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DROWNING AS A CAUSE OF MORTALITY IN MUSKRATS

By Paul L. Errington

It is well known that muskrats (*Ondatra* spp.) may be drowned by high waters, especially in lowland stream habitats or in like places subject to pronounced flooding. Not so well known are other types of drowning losses in environments having rather stable water levels, and some of these may be worthy of brief description.

The following observations were made in connection with recent field studies of *Ondatra zibethica* on Mud and Round lakes, two marshes of about 400 and 450 acres, respectively, in the vicinity of Ruthven, Iowa.

A beating rain fell the night of July 22, 1935, and the next day possibly 80 acres of Round Lake were thoroughly covered by canoe. Four carcasses of freshly killed muskrats were discovered floating in an area of less than 10 acres. Of the dead animals, one was an adult weighing about 800 grams and measuring 501 mm. in total length, and the others were young, roughly from 45 to 60 days old, between 195 and about 375 grams in weight, and from 331 to 414 mm. in length.

The animals had died from 200 to 300 yards from shore in a portion of the marsh into which, since early July, there had been a perceptible movement of adults and active sizes of young. Many of the newcomers had stationed themselves in temporary nests too flimsily built to afford adequate protection. Elsewhere on the marsh, the population still was mainly resident in lodges of more storm-resistant construction, and had withstood the violence of the storm without detected mortality.

Wave action of exceptional force on occasion may also be responsible for mortality. On April 24, 1937, Round Lake was swept by a storm reaching its height that night, during which the wind was said to have attained a velocity of 40 miles per hour. In the morning it was seen that some of the lodges in the 1936 reed growths (*Phragmites communis*) in the center of the marsh had disappeared. Carcasses of 5 muskrats washed in along a stretch of about 70 feet of shoreline, and associated débris indicated that an entire reed patch had been carried away, its muskrat occupants with it. Two additional carcasses were found April 28 in the course of a survey of the central reed patches remaining, but at least 31 muskrats were still living there.

The observed behavior of the Round Lake muskrats while the wind was abating gave evidence that they had survived something of an ordeal. The sky had cleared but the waves had subsided only slightly by the afternoon

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of April 25, at which time large numbers of the animals were to be seen on the shore, in both windy and sheltered situations. The majority were either asleep on windrows of débris or were feeding so voraciously in the adjacent land vegetation that they permitted me to approach within a short distance of them. Those asleep slept so soundly that I could stand over most of them and scrutinize their backs for metal identification tags (of which several hundred had been placed on the young of two previous summers). When awakened, the sleepers dived precipitately, but, where the buffeting of the waves was severe, they promptly were forced ashore unless they could find refuge in burrows. The apparent reluctance of certain muskrats to take advantage of well-used sets of bank burrows may indicate that they were out of their "home ranges" or, conceivably, out of their radii of familiarity.

In a lake or marsh, an increase in the water level may threaten more damage to young muskrats than to adults. Such increase need not be excessive to result in losses, particularly in the case of helpless new-born litters. New-born litters may often be left around in a haphazard manner—on butts of old lodges, flattened rushes, feeding rafts, coot nests, and in other low places. The tops of the larger lodges may offer reasonable safety to litters evicted from the chambers by flooding, but it by no means follows that the adults will place the young there during emergencies. The young may be distributed wherever the adults may chance to put them, and there they may remain unattended for hours, partly covered by wet, coarse vegetation, even wholly exposed, or lying in water of sufficient depth to drown some of them. Losses from outright drowning under such conditions, however, may actually be less than indirect losses from exposure or hunger, or the two combined. The exposure that a very young muskrat can endure is nevertheless surprising. An instance in point is provided by an individual two (?) days old, about 22 grams in weight, and 102 mm. in length, which was taken as a live specimen on the afternoon of May 3, 1935. By evening it was thought to be practically dead from chilling and was left overnight on a table in the field laboratory. At 5:30 A.M., after a night in which the room temperature had fallen nearly to the freezing point, the supposedly dead animal moved almost imperceptibly when held in hand; it was then warmed by body heat and revived in 15 minutes to a very lively state.

At about the age when the young are weaned, their activities may take the form of random tunnelling through the smaller or less permanent lodges, with the effect of spreading and flattening the tops. Chambers and nests are improvised as desired but at consequently lower levels, so that they may be in danger of flooding in the event of heavy rains.

June 18, 1935, was the second day of a cold rain, and it could be seen that some litters on Mud Lake were not faring well. One litter was protected from the direct fall of the rain by an adult lying over the open nest, but the

heaped young underneath were more in than out of the water. The young at the bottom were pushed completely under water by the weight of the others. They came to the surface to squeeze in among the upper ones, and, with each withdrawal, the squirming pile sank again. By the next day, there were 3 alive on top of 5 dead ones. Another litter lost 2 of 4 young in somewhat the same way.

These litters were about 23 and 27 days old, respectively, and the dead members, watersoaked as they were, averaged but 102 and 114 grams, or about 80 per cent of their calculated proper weights. The decline in weights was ascribed to a lack of food in their digestive systems; and their unfed condition, in turn, may have contributed substantially to their final exhaustion and death.

Not all of the muskrat mortality from drowning results from rising water levels or bad weather. Considerable loss may occur throughout the breeding season as suckling young may be inadvertently pulled into the water by their mothers.

It is true that some of the losses recorded from this source must be charged to human observers for disturbing mother muskrats at times when young are being nursed. On the other hand, predation, competitive strife, and such factors, are a natural background of muskrat family life, and evidences thereof may be encountered on initial visits to given tracts of marsh, i.e., drowned young of semi-helpless sizes floating outside of the lodges or in rushes near by, and living young of comparable helplessness found now and then in obviously irregular places.

Young of less than 5 days (about 35 grams and 135 mm.) seldom appear to be firmly enough attached to their mother's teats to be taken into the water if she plunges suddenly, although she may scatter or injure some of them in her haste. Larger sizes are more likely to be carried clear of the lodge, to emerge in the wake of the mother at distances ranging from a few feet to 40 yards or more.

It has been demonstrated experimentally that the blind but swimming young about 10 days old (about 55 grams and 165 mm.) stand a fair chance of saving themselves from drowning by crawling onto various raised or floating objects that usually are to be found in densely grown marshes. With the opening of their eyes and the gain in size and strength during their subsequent development, the young become noticeably more adept at finding some kind of sanctuary if they discover themselves swimming unexpectedly in strange waters.

Young of dependent sizes can withstand a limited amount of wetting without evident discomfort, but after a few minutes of chilled loneliness on the landing of a lodge, or in a clump of rushes, they may begin to complain persistently. The complaints may grow in volume as relief by the mother is delayed, and this doubtless has an important rôle in the saving of young

that otherwise would be lost, as mother muskrats may be very lax in gathering together their missing offspring.

Commonly, the mother dives hastily when alarmed, with or without young attached, and she follows a definite underwater route from the lodge to her habitual feeding ground or to a bank runway. Possibly 10 minutes may elapse before she returns over the same route, swimming on the surface. Incidentally, she may pick up a bedraggled youngster that has been whimpering in the rushes and take it to the nest. She may then dress her fur, feed, or do some work on the lodge. Meanwhile, one or two young may have been swimming aimlessly around until drowned. She may swim casually out again and find another young and return with it, or she may continue on to the feeding grounds. On her way back, the complaints of one more young may come to her notice and she may bring it in with her. She may retrieve most of her litter eventually or she may not. One thing at a time is seemingly all that she can remember, and her attention is easily distracted.

The significance of the losses from drowning so far observed in the Iowa muskrat investigations is difficult to evaluate. On the whole, the mortality rates from this cause appear to rise under natural conditions as population densities rise, with corresponding increase of intraspecific friction and occupancy of less favorable habitats. The relation between increasing population density and drowning of young through negligence of adults has been rather apparent in our studies, although we cannot say how strictly it may hold true under varying circumstances. Life tends to cheapen as it becomes abundant, and this is certainly the case in an over-populated area on a muskrat marsh, where a few young more or less are not likely to make much difference, anyway, even to their parents.

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THE VISCERAL ANATOMY OF AN INFANT CHIMPANZEE

By William L. Straus, Jr.

This communication deals with some of the more interesting morphological features in the thoracic and abdominal viscera of an infant female chimpanzee, "Panacea". This animal, born in the Department of Anatomy, The Johns Hopkins University, on December 22, 1936, died of pneumococcus type III pneumonia on March 6, 1937, at the age of 74 days. It was embalmed, within one-half hour following death, with 10 per cent formalin injected through the heart. Sitting height and trunk height, measured after fixation, were 31.5 cm. and 16.8 cm., respectively.

Although the literature contains a number of descriptions of the viscera of chimpanzees, none of these apparently deal with so young an animal. In a previous communication (1936), I described the thoracic and abdominal organs of an infant female orang-utan (U. S. Nat. Mus. no. 153,825) (fixed in 70 per cent alcohol). Comparison will be made with this individual and with a juvenal male chimpanzee, dissected several years ago, (J. H. Anat. no. 162) (fixed in 10 per cent formalin), said to be 4 years old.

The left *lung* has 2 lobes, the right lung 3; the human formula. An azygos lobe thus is absent, but the lower right lobe sends a definite and marked process behind the inferior vena cava that suggests, both in form and position, the free lobus azygos of monkeys. The lobar formula also is L2, R3 in the juvenal male chimpanzee. The lungs of the infant female orang-utan, however, exhibit the complete absence of gross lobation characteristic of that genus. A marked cardiac notch is present in the left lung of each infant.

The *thymus*, like that of man, definitely is bilobate, being formed of right and left lobes of about equal size. These cover the upper part of the pericardium and do not extend markedly into the neck. This structure is almost identical in the infant orang. Sonntag (1924) also found two lobes in a chimpanzee, as did Woollard (1925) in *Tarsius*. Three lobes, however, have been described for the gorilla, gibbon and catarrhine monkeys (cf. Straus, 1936). A third or intermediate lobe sometimes occurs also in man.

The *stomach*—empty at death—is globular. There is a well-marked fundus, but the left part of the organ is not very large. The general gastric shape is quite different from that of the infant orang, in which it is long and curved (see Straus, 1936, fig. 5H). The cone-shaped projection of the fundus found in the latter animal likewise is lacking.

The pyloric antrum is not clearly demarcated. This also is the condition in the infant orang. In the juvenal chimpanzee, however, the antrum definitely is bounded by a ridge.

Length along the lesser curvature of the stomach from esophagus to duodenum measures 4.5 cm.; along the greater curvature, 15 cm. The same

measurements in the infant orang are 5.5 cm. and 12 cm.; in the juvenal chimpanzee 7 cm. and 25.5 cm. Hence the ratio of lesser to greater curvature is 1 to 3.33 in "Panacea", and 1 to 3.64 in the older chimpanzee, but 1 to 2.18 in the young orang.

The *duodenum* measures 5.5 cm. in length. It comprises a short superior and long descending and horizontal portions. A fourth or terminal ascending section is lacking. Valvulae conniventes (plicae circulares) are absent. The common bile and pancreatic ducts do not unite to form an ampulla but enter the duodenum obliquely and separately to open internally on a large raised eminence. No accessory pancreatic duct was discovered.

The duodenum is 11 cm. long in the juvenal chimpanzee. A pars ascendens likewise is absent. It can occur, however, in the chimpanzee (Sonntag, 1923). Valvulae conniventes also are lacking.

Duodenal length is 5.5 cm. in the young orang-utan. There is an ascending portion. Definite valvulae conniventes are apparent, particularly in the first part of the tube. The common bile and pancreatic ducts open separately upon a prominent papilla major. There is no accessory pancreatic duct.

Relative duodenal length (jejuno-ileum = 1) is 0.04 in "Panacea", 0.05 in both the older chimpanzee and the young orang-utan.

The *jejuno-ileum* exhibits the customary complex coils. It measures 148.5 cm. in length. This measurement is 237.5 cm. in the juvenal chimpanzee and 102 cm. in the infant orang-utan.

The *caecum*, which is 3.5 cm. long, is of the customary infantile or fetal type, that which Treves (1885) has termed type 1; thus the caecal apex forms a cone that tapers into the *vermiform appendix*. The latter is somewhat twisted upon itself, especially near its end. It points to the left and is partly retrocaecal in location. The appendix measures 5.5 cm. in length.

In the juvenal chimpanzee the caecal length is 5 cm. The organ is of Treves' type 3, the base of the vermiform appendix being displaced toward the ileo-caecal junction. The slender appendix is somewhat twisted, but is not spiralled. It measures 10.5 cm. in length.

The caecum of the infant orang-utan, which also belongs to Treves' type 3, is quite short, measuring only 2 cm. The vermiform appendix is relatively of great length (8.5 cm.) and is greatly twisted in a spiral fashion.

Relative length of caecum, when small intestine = 1, is 0.02 in both "Panacea" and the juvenal chimpanzee, and 0.01 in the infant orang. When length of colon is substituted for that of small bowel, the ratios are 0.06, 0.07 and 0.04, respectively.

Relative length of vermiform appendix (caecum = 1) is 1.57 in "Panacea", 2.10 in the juvenal chimpanzee, and 4.25 in the infant orang. Apparently the appendix becomes comparatively shorter (to caecum) with advancing growth in both orang-utan and man (Straus, 1936). There is no evidence, however, that such a change occurs in the chimpanzee.

There is a well-marked *ileo-caecal valve*, the two lips being prolonged postero-laterally to form a prominent frenulum. Instead of developing two definite lips in the young orang-utan, however, the valve appears as a prominent crescentic fold that fades out laterally as a frenulum; this conditional possibly is phasic, a result of post mortem relaxation. The ileo-caecal junction of the juvenal chimpanzee, on the other hand, differs fundamentally; the ileal orifice, which is constricted, projects into the caecum as a definite papilla, much as in certain platyrrhines and lemurs.

The *colon* consists of ascending, transverse, descending and sigmoid portions. The ascending colon is well-defined and passes over at the hepatic flexure into the almost straight transverse colon. A typical descending colon scarcely exists, for just below the splenic flexure the large bowel bends sharply to the right, almost reaching the ascending colon, and then recurs to form a remarkably extensive sigmoid colon. The latter is seen virtually to conceal the small intestine when the greater omentum is raised. Finally, after completing a typical sigmoid flexure, the colon forms an additional corkscrew turn before passing into the rectum. There are three taeniae over the entire colon. These extend down onto the caecum and converge upon the base of the appendix. Length of colon is 56.5 cm. The sigmoid is by far the longest portion.

All four sections of the colon are apparent in the older chimpanzee. The transverse colon is not straight, but sags so as to form a distinct loop. There is a sharp sigmoid flexure. The three taeniae coli converge upon the appendix. Length of colon is 69.5 cm.

In the infant orang-utan the ascending segment of the colon is abbreviated in comparison with the descending portion. Two loops occur in the course of the transverse colon. The long sigmoid colon forms closely packed loops. There are three well-marked colic taeniae. These disappear, however, over the upper caecum. Length of colon is 49 cm.

Relative length of colon (when small intestine = 1) is 0.36 in "Panacea", 0.27 in the juvenal chimpanzee, and 0.45 in the infant orang. This is an extremely variable proportion and individual figures are of little significance (cf. Straus, 1936).

The *greater omentum* is by no means extensive. It is firmly adherent to the serosa of the transverse colon. Both duodenum and pancreas appear to be entirely retroperitoneal in location. On the other hand, there is a long, conspicuous *mesocolon* for all parts of the colon. The well-developed *mesappendix* clearly is derived from the part of the mesentery proper going to the ileum. Both the superior and inferior ileo-caecal recesses are large. No distinct *epiploic appendices* are formed.

In the juvenal chimpanzee, the greater omentum also is attached to the transverse colon. Duodenum and pancreas clearly are retroperitoneal. There is a general mesocolon, only the first part of the ascending colon and

apparently the upper part of the descending colon being retroperitoneal. In other chimpanzees, as those of Reider (1936) and Sonntag (1923), however, the ascending and descending portions have no mesocolons, as in most men. The mesappendix comes from the serous covering of the ileum. Large epiploic appendices occur.

The small greater omentum in the infant orang-utan adheres to the transverse colon. Both duodenum and pancreas are retroperitoneal. There is an ascending mesocolon that is rather short in contrast with those of the transverse and sigmoid sections of the large bowel. The descending colon, however, is entirely retroperitoneal. A strong mesappendix is present. Superior and inferior ileo-caecal recesses occur, the latter being particularly well-developed. Epiploic appendices are numerous.

The *liver* of "Panacea" is almost an exact counterpart of that found in the juvenal chimpanzee. The latter already has been figured by me elsewhere (Straus, 1936, fig. 15 F). There are three main lobes: left, right and Spigelian. The right lobe is very much larger than the left. Both portions of the Spigelian lobe—papillary and caudate—are relatively large. There is a tendency toward minor lobulation. Thus the left lobe forms a prominent accessory lobule projecting between the upper part of the umbilical fissure and the papillary lobule. Furthermore, there is a second accessory lobule along the right margin of the quadrate region of the right lobe, bordering the gall-bladder. The parumbilical lobule of the right lobe that occurs in the juvenile is absent in "Panacea", but is suggested by a rather prominent elevation of liver tissue in this location. A vestige of the primitive fissure between the basic right central and right lateral lobes definitely occurs in the infant, in the form of a notch along the middle of the right margin of the liver; this is continued inward to the gall-bladder as a shallow furrow dorsally. This does not occur in the juvenile. The inferior vena cava is surrounded by hepatic tissue. The prominent gall-bladder projects beyond the border of the liver, and its lowest part occupies a notch on the lower margin of the organ. Such notching is not found, however, in the older animal. There is a very deep umbilical fissure forming a deep notch along the lower liver border. The bare area seems to be relatively small in the infant. I have no record of its extent in the juvenile. Liver weight is 130 gm. in "Panacea", as compared with 331 gm. in the juvenile. There is no evidence of congestion.

The liver of the infant orang likewise is divided into left, right and Spigelian lobes. The right lobe is very much larger than the left. Although the Spigelian lobe is well-developed, this is due chiefly to the papillary portion—which is of considerable magnitude—for the caudate lobule, although prominent, is somewhat smaller relatively than in the chimpanzees. There is, furthermore, not the slightest tendency toward minor fissuration or lobulation. The vena cava is surrounded by liver tissue; this is of normal occurrence in all primates except man and gibbon (and probably some platyrrhines,

as *Ateles* and *Lagothrix*). There is no umbilical fissure or fossa, since the ligamentum teres penetrates the liver at its inferior border. Liver weight is only 55 gm.

Relative weight of the liver (combined weight of the kidneys = 1) is 5.00 in "Panacea", 4.24 in the juvenal chimpanzee, and 5.50 in the infant orang.

The *pancreas*, which lies in the curve of the duodenum, is very long and extends toward the spleen. Its weight is 3 gm. in "Panacea", 23 gm. in the juvenal chimpanzee, and 2 gm. in the young orang.

Relative pancreas weight, when compared with the liver (= 1), is 0.02 in "Panacea", 0.07 in the juvenal chimpanzee, and 0.04 in the infant orang. Using the kidneys (combined weight) as the unit standard in place of the liver, the ratios are 0.12, 0.29 and 0.20, respectively. The data relating to the chimpanzee are in agreement with those presented by me elsewhere (Straus, 1936, pp. 69–70), indicating that the pancreas of catarrhines undergoes a comparatively greater postnatal increase in weight than do any of the other solid abdominal viscera.

The *spleen* is quite elongate and more closely resembles that of Old World monkeys than of man. It also tends toward relative elongation in the infant orang, but is more compact in the juvenal chimpanzee. As is well known, however, splenic form is quite variable and more or less ephemeral. Hence this character definitely is of limited value. Weight of spleen is approximately 13 gm. in "Panacea", 35 gm. in the older chimpanzee, and 10 gm. in the infant orang. Relative weight of the organ, when liver = 1, is 0.10 in "Panacea", 0.11 in the juvenal chimpanzee, and 0.18 in the orang. When kidneys = 1, the ratios are 0.50, 0.45 and 1.00, respectively.

The *kidneys*, in contrast with those of the human infant, exhibit no real external lobulation. Each, however, possesses a deep furrow—better marked on the anterior surface of the organ—that extends laterally from the hilum and tends to divide the kidney into superior and inferior segments. A similar, although shallower, furrow is present in the infant orang, but in this animal also no real superficial lobulation is indicated. Internally, each kidney of "Panacea" reveals but a single primary medullary pyramid that ends in a definite although not exceedingly prominent papilla. Hence the kidneys are of my type C (see Straus, 1934). This type is most common in chimpanzees. There are at least 4 secondary pyramids in each organ. The kidneys of the infant orange are of the same type. Combined weight of the two kidneys is 26 gm. in "Panacea", 78 gm. in the juvenal chimpanzee, and 10 gm. in the young orang.

The left kidney is situated considerably inferior to the right. It extends from the upper border of the last rib to below the crest of the ilium. The right kidney begins just superior to the penultimate rib and its lower pole also overlaps the iliac crest. The right kidney is the more caudal in the juvenal chimpanzee, while the two lie at the same level in the infant orang.

These probably do not represent age differences, for the bilateral topographical relations appear to be variable within a genus.

Both *adrenal glands* are relatively large, each weighing slightly less than 2 gm. They cap the upper poles of the kidneys and, pointing medially, extend almost to the midline of the trunk. Their shape is typically human, resembling that of a cocked hat. Conditions in the young orang are essentially similar; each gland weighs 1 gm. Adrenal weight is to kidney weight as 0.15 to 1 in "Panacea", and 0.20 to 1 in the infant orang.

Respecting the province of the *inferior mesenteric artery*, "Panacea" resembles man, as do older chimpanzees (cf. Reider, 1936). It begins at about the middle of the transverse colon—where there is anastomosis with the superior mesenteric artery—and includes all of the colon beyond this point.

The *inferior vena cava* is entirely double below the entrance of the renal veins, with the abdominal aorta lying between the two vessels. This represents an anomalous persistence of one of the left inferior cardinal veins.

In its general visceral morphology, "Panacea" agrees much more closely with the older chimpanzee than with the infant orang-utan. Indeed, in several important characters—as pulmonary lobation and form of stomach, duodenum, caecum and liver—the contrasts between the two infants are quite striking. On the other hand, the two chimpanzees differ only with respect to the precise form of certain sections of the digestive tube. Whether these differences actually are of ontogenetic character or whether they merely represent individual variations without any developmental significance, cannot be stated in the absence of further material, particularly of the infantile stage.

SUMMARY

The left lung of "Panacea" has 2 lobes, the right 3.

The thymus is bilobate.

The stomach is globular, but with reduced left portion and poorly defined antrum.

There is no ascending portion in the duodenum. Valvulae conniventes do not occur.

The caecum is of Treves' 1st type. Length of appendix is 1.57 times that of caecum.

There are the four customary divisions of the colon, but the descending is abbreviated and the sigmoid relatively enormous.

Both duodenum and pancreas are retroperitoneal, but all of the colon has a long mesocolon. There are no distinct epiploic appendices.

The liver exhibits right (largest), left, and Spigelian (well-developed) lobes. There is a tendency toward minor lobulation, and a vestige of the fissure primitively dividing the right lobe into lateral and central parts.

The pancreas is of relatively small weight.

The spleen is comparatively elongate as in Old World monkeys.

No real external renal lobulation is apparent. Internally, the kidneys are of Straus' type C.

The adrenal glands are relatively large and of human form.

Caudal to the kidneys the inferior vena cava is double.

With respect to general visceral morphology, "Panacea" more closely resembles the older chimpanzee than she resembles the infant orang-utan.

LITERATURE CITED

REIDER, N. 1936. The primate colon. Proc. Zool. Soc. London, pp. 433–453.

SONNTAG, C. F. 1923. On the anatomy, physiology and pathology of the chimpanzee. Proc. Zool. Soc. London, pp. 323–429.

——— 1924. The Morphology and Evolution of the Apes and Man. 364 pp., London.

STRAUS, W. L., JR. 1934. The structure of the primate kidney. Jour. Anat., vol. 69, pp. 93–108.

——— 1936. The thoracic and abdominal viscera of primates, with special reference to the orang-utan. Proc. Amer. Philos. Soc., vol. 76, pp. 1–85.

TREVES, F. 1885. Lectures on the anatomy of the intestinal canal and peritoneum in man. Brit. Med. Jour., vol. I for 1885.

WOOLLARD, H. H. 1925. The anatomy of Tarsius spectrum. Proc. Zool. Soc. London, pp. 1071–1184.

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TAXONOMIC OBSERVATIONS ON WHITE WHALES

BY I. I. BARABASH

Klumov (1935), after studying white whales captured in the White Sea, decided that he had found morphological details which indicated the existence of a hitherto unrecognized species of *Delphinapterus*. To this whale he gave the name *Delphinapterus freimani*. During the same year my own studies on the cranial peculiarities of the White Sea *Delphinapterus* confirmed the validity of this new species. On the basis of external and cranial characters, Barabash and Klumov (1935) proposed the name *Delphinapterus dorofeevi* for the white whale of Okhotsk Sea.

The main purpose of this paper is to summarize the principal cranial characters of the two above-mentioned kinds of white whales and to compare them with the corresponding features of *Delphinapterus leucas* Pallas.

Through the coöperation of the Laboratory of Marine Mammals of the Scientific Research Institute of Sea-fishery Economics and Oceanography at Moscou, I have studied 39 skulls belonging in part to the above laboratory and in part to the Zoological Museum of the First Moscou State University. I have also examined skulls of white whales belonging to the Zoological Institute of the Academy of Science. These 39 skulls came from the following localities: White Sea, 10; Gulf of Ob, 22; Okhotsk Sea, 7; Nova Zembla, 2; Spitzbergen, 1; Greenland, 1.

In this study of geographic variation in the white whale, it was necessary to examine critically a large number of cranial details. Adult skulls only were utilized in these comparisons. Individual variation is rather marked in *Delphinapterus* skulls. Sufficient material is not as yet available to undertake a revision of the genus *Delphinapterus*. It is possible, however, at the present time to define the cranial details of the following three species: *Delphinapterus freimani* Klumov of the White Sea; *Delphinapterus leucas* Pallas of the Gulf of Ob; and *Delphinapterus dorofeevi* Barabash and Klumov of the Okhotsk Sea.

The two new species of *Delphinapterus* described in 1935 are characterized as follows:

Delphinapterus freimani Klumov. White Sea white whale. Braincase wider than that of *Delphinapterus leucas* (relation of greatest breadth to total length of skull averages 54.5 per cent, as compared to 50.8 per cent for *D. leucas*); skull somewhat flattened (relation of height to greatest breadth of skull averages 67.7 per cent, as compared to 73.2 per cent for *D. leucas*); rostrum shortened (relation of length of rostrum to total length of skull averages 44.1 per cent, as compared to 50 per cent for *D. leucas*).

In breadth and height the skull of this species approaches that of *Delphinapterus dorofeevi*, but is distinguished from the latter, as well as from *D. leucas*, by the short rostrum.

Delphinapterus dorofeevi Barabash and Klumov. Okhotsk Sea white whale. Relative height of skull less than that of *D. leucas* (relation of greatest height to greatest breadth of skull averages 69.1 per cent, as compared to 73.2 per cent for *D. leucas*; and relation of height of braincase to greatest breadth of skull averages 58 per cent, as compared to 60.9 per cent for *D. leucas*); rostrum wider at base (relation of breadth of rostrum at base to greatest breadth of skull averages 61 per cent, as compared to 58.7 per cent for *D. leucas*); mandible somewhat narrower than that of *D. leucas* (relation of breadth at base to length of mandible somewhat narrower than that of *D. leucas*; relation of breadth at base to length of mandible averages 24.6 per cent, as compared to 26.1 per cent for *D. leucas*).

The flattened dorsal profile as well as the greater width of the rostrum at the base distinguish the skull of this species from that of *D. leucas*. In general the skull of *D. dorofeevi* is more massive and the rostrum straighter than in *D. leucas*.

In conclusion I should like to say that I have measured also 2 skulls from Nova Zembla, 1 from Spitzbergen and 1 from Greenland. All of them more or less approach *Delphinapterus leucas*. Unfortunately at present we lack sufficient material to determine the taxonomic status of the white whales occurring in those regions.

Many of the published descriptions of white whales, as for instance those of Cope (1865, 1869 in Scammon), are inadequate for purposes of comparison. In addition, most of these names have been applied to white whales occurring

along the Atlantic Coast of North America. It is hoped that the method of analysis of *Delphinapterus* outlined above will serve as a basis for a more precise understanding of geographic differentiation in the white whale.

LITERATURE CITED

ARSENIEV, V. A. 1936. A morphological characteristic of the Far Eastern white whale. Bull. Far Eastern Branch Acad. Sci. USSR, Vladivostok, no. 19, pp. 131–144.

BARABASH, I. I., AND S. KLUMOV. 1935. The Pacific Ocean form of white whale. Biulleten' rybnogo Khoziaistvo SSSR (Sea Fishery Economics in USSR), Moscou, number 11, p. 24. (In Russian. New: *Delphinapterus dorofeevi*.)

CHAPSKY, K. K. 1937. Migrations and hunting of white whale in the northern part of Ob Bay. Trans. Arctic Inst., Leningrad, vol. 71, Biol., pp. 60, figs. 7.

COPE, E. D. 1865. Second contribution to a history of the Delphinidae. Proc. Acad. Nat. Sci. Philadelphia, vol. 17, no. 5, pp. 278–281. December, 1865. [*Beluga rhinodon, B. catadon, B. declivis, B. concreta*, as well as *B. canadensis, B. kingii*.]

HEPTNER, WL. G. 1930. Materiale zur Kenntnis der geographischen Verbreitung und Biologie des Weisswales (Delphinapterus). Trudy Nauchno-Issledovatel'-skogo Instituta Zoologii (Works Sci. Invest. Inst. Zool.), Moscou, vol. 4, no. 2, pp. 7–100, figs. 8. 1930 (In Russian.)

KLUMOV, S. 1935. The new form of white whale. Biulleten' rybnogo Khoziaistvo SSSR (Sea Fishery Economics in USSR), Moscou, no. 7, pp. 26–28, figs. 2. (In Russian. New: *Delphinapterus freimani*.)

KLUMOV, S. K. 1937. A new form of Belukha. Bull. Acad. Sci. URSS, cl. sci. math. et nat., ser. biol., Moscou, no. 1, pp. 199–209, figs. 7. (*Delphinapterus dorofeevi* and *D. freimani*.)

OSTROUMOV, N. A. 1935. Contribution to the systematics and distribution of the white whales of northern Europe and the Kara Sea. Za Ribnooyou Industriyou Severa, no. 11.

PALLAS, P. S. 1776. Reise durch verschiedene Provinzen des Ruszischen Reichs, Erster Theil (Vignette), St. Petersburg, 1771, pp. 10 + 3 + 504, pls. A-L, 1-10b maps; Zeyter Theil, Erstes Buch, 1773, pp. 4 + 3–368 + 6 + pls. A-Z + map; Zweyter Theil, Zweytes Buch, 1771, pp. 371–744, pls. 1–14 + map; Dritter Theil, 1772–1773, 1776, pp. 20 + 3–454, pls. A-Nn + 1–6 + map; Reise aus Sibirien zurück and die Wolga im 1773ten Jahr. Des Dritten Theil, Zweytes Buch, pp. 760 + 26, pl. 8.

——— 1811. Zoographia Rosso-Asiatica, sistens omnium Animalium in extenso Imperio Rossico, et adjacentibus maribus observatorum recensionem, domicilia, mores et descriptiones anatomen atque icones plurimorum. Petropoli, 3 vols.

SCAMMON, C. M. 1869. On the cetaceans of the western coast of North America (with introductory note by E. D. Cope). Proc. Acad. Nat. Sci. Philadelphia, vol. 21, pp. 13–63, figs. 17. April, 1869. [pp. 23–31; *Beluga rhinodon, B. declivis, B. angustata, B. concreta*.]

STELLER, G. W. 1774. Beschreibung von dem Lande Kamtschatka dessen Einwohnern, deren Sitten, Nahmen, Lebensart und verschiedenen Gewohnheiten herausgeben von Jean Benoit Scherer, Frankfurt und Leipzig, pp. vi + 24 + iv + 384 + 72, pls. 10, 2 folding maps.

TRUE, FREDERICK W. 1889. A review of the family Delphinidae. Contributions to the natural history of the cetaceans. Bull. 36, U. S. Nat. Mus., pp. 191, pls. 47.

The Agricultural Institute, Saratov 19, Moscou, U.S.S.R.

DESCRIPTION OF A RACE OF PEROGNATHUS LONGIMEMBRIS FROM TULARE COUNTY, CALIFORNIA

By William Bebb Richardson

The pocket mouse *Perognathus longimembris* has a wide range in the desert area to the east and south of the southern Sierra Nevada, and it ordinarily inhabits open places where there is dry sandy soil of relatively fine texture. The writer collected a series of dark-colored specimens of this species in the Sierra Nevada of southeastern Tulare County in the summer of 1936. This area is on the periphery of the range of *P. l. longimembris* (Coues). Study of the geographic variation in *Perognathus longimembris* has led to the conclusion that the specimens from southeastern Tulare County represent a population which merits a new subspecific name.

Perognathus longimembris tularensis, new subspecies

Type.—Adult male, skin and skull; no. 74668, Mus. Vert. Zool.; from one mile west of Kennedy Meadows, 6000 feet, South Fork Kern River, Tulare County, California; collected August 14, 1936, by Wm. B. Richardson, orig. no. 2004.

Distribution.—Known only from Kennedy and Chimney meadows in the southern Sierra Nevada, but probably occurs in the northern drainage area of the South Fork of the Kern River, from the vicinity of the Tulare-Kern County line north to Windy Springs.

Diagnosis.—Dorsal surface dark; arietiform facial markings black, indistinctly joined above nose pad; skull small.

Comparisons.—Compared with *P. l. longimembris:* Dorsum darker; tail shorter, more densely clothed with hair, and darker on upper surface and terminal tuft. Skull smaller; mastoids smaller, less expanded, and more ovate. Compared with *P. l. panamintinus:* Body shorter; dorsum darker, black of hair tips predominant in dorsal color, rather than the reddish tan of subterminal bands; tail darker dorsally; facial markings black, rather than deep brown. Skull with mastoid breadth less, interorbital space slightly narrower. No comparison is necessary with the pale *Perognathus pericalles* Elliot (a synonym of *P. l. longimembris*) from Keeler, Inyo County, California.

Color (capitalized color terms after Ridgway, Color Standards and Color Nomenclature, 1912).—Tips of dorsal hairs Black, obscuring in part the Light Ochraceous-Buff of subterminal bands; basal portion of hairs Light Payne's Gray; under parts and feet White; face with pronounced black crescent extending on each side from tip of nose through base of vibrissae; tail generally distinctly bicolored, ventral surface Pale Ochraceous-Buff, dorsal surface varying from Black to Mummy Brown, ending in a dark tuft.

Measurements (in millimeters).—Type and one adult female paratype respectively: Total length, 127, 135; tail, 68, 72; hind foot, 19, 20; ear from notch, 7, 7; occipitonasal length, 21.7, 21.5; frontonasal length, 14.6, 14.4; breadth of skull at mastoids, 11.7, 11.5; length of mastoid, 8.2, 8.1; distance between stylomastoid foramina, 10.5, 10.6; interorbital space, 5.2, 5.2. Average and extreme measurements of two male (adult and subadult) and three female (one adult and two sub-adult) paratypes: Total length, 123.8 (112–130); tail*, 67.7 (64–73); hind foot, 18.4 (18–19); ear from notch, 6.2 (6–7); occipitonasal length, 21 (20.1–21.8); frontonasal length, 14.1 (13.4–14.8); breadth of skull at mastoids*, 11.2 (10.5–11.9); length of mastoid, 8 (7.6–8.3); distance between stylomastoid foramina, 10.3 (10.1–10.5); interorbital space, 5.2 (5.1–5.2). (*Three specimens measured.)

Remarks.—This dark race of the species *longimembris* is apparently restricted to a relatively small area near the type locality. The two specimens of *tularensis* from Chimney Meadows are lighter in color than those from Kennedy Meadows. Specimens (Mus. Vert. Zool.) of *P. l. longimembris* from Lone Pine Creek, 6600 feet, and East Sacatar Cañon, 6000 feet, on the east slope of the Sierra Nevada, approach *tularensis* in color. This suggests intergradation with *longimembris* across the southern Sierra Nevada, through intermediate populations which occur along the western side of Owens Valley at least as far as Lone Pine Creek.

Specimens examined.—Nine from the following localities in Tulare County, California; 1 mi. W. Kennedy Meadows, 6000 ft., South Fork Kern River, 7; Chimney Meadows, 6200 ft., 2.

Museum of Vertebrate Zoology, University of California, Berkeley, California.

GENERAL NOTES

SOME MAMMALS OF WESTERN SOUTH CAROLINA

In our work on the fauna of South Carolina, we have accumulated several records of mammals that seem worthy of publication.

Clemson College (land-grant college of South Carolina) is in Oconee County, the westernmost county of the state, at approximately 775 feet elevation, at the edge of the foothills of the Blue Ridge and Appalachian mountains, which within 40 miles rise to above 3000 feet elevation within the state.

Cryptotis parva, little short-tailed shrew.—Clemson College, November 20, 1927, taken by D. Dunavan (skin). Jocassee, March 30, 1930, taken by J. A. Berly (spirit specimen). CCC Camp F-2, May 28, 1934, sent by T. D. Brohun (skin). All three localities in Oconee County at elevations from 750 to 2500 feet. It is also recorded elsewhere in the state.

Mustela frenata noveboracensis, southern weasel.—My veteran naturalist friend, Mr. C. S. Brimley at Raleigh, N. C., once wrote me that any genuine record of a weasel in South Carolina is worthwhile. This species is quite common at Clemson College. My records show that we trapped two along Seneca River in late 1925, and two early in 1926 (skins). We have not trapped for it recently but specimens are occasionally brought to me. I am told that it is "plentiful" in the nearby South Carolina mountains.

Lutra canadensis lataxina, Carolina otter.—We have one poor skin, a specimen seined from the South Carolina shore of Savannah River near Anderson. This wary animal, although presumably scarce and on the decrease, is probably more widespread and more numerous than is generally appreciated. Various persons have assured me of its occasional capture, and an intelligent resident in the nearby South Carolina mountains tells me there are still a few in that section.

Marmota monax monax, southern woodchuck.—This species, generally considered as northern, is regularly present and even common in our mountainous area. A twelve-pound specimen from Oconee County was brought to us in September, 1929 (mounted). At least one has been captured at Clemson College, and we have a few scattered records from farther eastward.

Tamias striatus striatus, eastern chipmunk.—This species is abundant on the Clemson College campus, and common westward into our South Carolina mountains. It occurs at least 20 miles east, to Anderson, South Carolina.

Sciurus hudsonicus abieticola, southern red squirrel.—For years I have known this species (locally known as boomer) in the mountains of western North Carolina and had seen it within about 15 miles of the South Carolina State line. Natives of our South Carolina mountains had assured me that it occurs within this state but there was no accepted record in the literature. On May 20, 1937, Mr. L. C. King, working at the newly-established federal trout hatchery in the northern part of Oconee County, collected an adult female and presented it to me. It is now preserved as a skin in the Clemson collections. The date and temperatures at the time, combined with the mild winter preceding, make it virtually certain that the species is an all-year resident in that locality as our mountaineers assert, and not merely a migrant after winter storms. Natives assert that it is very partial to hemlock trees, which are abundant and grow to a large size along our mountain streams.

Ondatra zibethica zibethica, common muskrat.—Common at Clemson College along Seneca River, several being trapped during the winter of 1925-1926 and again in the fall of 1929, but said to be fewer than in former years, (skin and mounted specimens in Clemson collections). Mr. B. P. Rogers, an intelligent mountaineer, told me that there are a few along streams and in marshy places in the mountains, but not as many as in the foothills below.

Zapus hudsonius americanus, Carolinian jumping mouse.—Mr. R. B. Casey, student at this college, trapped a specimen of this mouse along a ditch-bank in a grassy meadow on the Clemson College farm, November 7, 1928. The specimen had been partly devoured and only the posterior portion (including hind legs, tail, and part of back) was preservable (skin in Riker mount, in Clemson collections). The specimen was examined in May 1934, by Dr. H. H. T. Jackson of the Bureau of Biological Survey, who identified it as above.—FRANKLIN SHERMAN, *Clemson College, Clemson, South Carolina.*

ANAESTHETIZING MAMMALS

The foregoing article, "Deodorizing skunks," by Vernon Bailey (p. 481) brings to mind the question of the use of anaesthetics on captive wild animals. Even the most humanely inclined individual may find it necessary to amputate an injured limb or otherwise treat an animal in a manner that will cause pain. This is particularly so in zoos, where medication and a certain amount of surgery is a necessary part of the routine. Even where pain is not involved, as in administering medicine to a recalcitrant individual, the excitement incident to its forcible administration may prove to be more harmful than would a moderate amount of pain.

The term anaesthesia when applied to a lower mammal is most apt, perhaps, to bring to mind an ether cone, a struggling subject in great fright held forcibly by an assistant, and the ever present danger of an overdose—for different animals react very differently to ether. The administration of ether to a full-grown skunk brings up a still more horrid picture, chiefly involving the operator, and is a task to be undertaken with misgiving even by the most intrepid individual.

Modern anaesthetics offer far more desirable methods than the employment of ether, however. One of the most dependable drugs that can be used at present is nembutal (Abbott Laboratories, North Chicago, Illinois). A safe dosage is one-sixth grain per pound of live weight, and it should be administered on an empty stomach in milk or other acceptable food. It is readily taken and the animal soon falls into a natural-appearing sleep for an hour or two, with no undesirable after-effects. Some animals are more resistant to the drug than are others, and if complete insensibility does not occur, a few whiffs of ether will complete any desired degree of anaesthesia.

By this method the shock of forcibly controlling a recalcitrant animal is entirely avoided, and any mammal may be treated or examined without excitement.—A. BRAZIER HOWELL, *Department of Anatomy, Johns Hopkins University, Baltimore, Maryland.*

THE NOVA SCOTIAN SMOKY SHREW IN NEW HAMPSHIRE

On August 25, 1936, A. E. Preble captured a specimen of *Sorex fumeus*, at the First Connecticut Lake, 7 miles north of Pittsburgh, New Hampshire. Dr. Hartley H. T. Jackson of the Bureau of Biological Survey, kindly identified the specimen as *Sorex fumeus umbrosus*, which, hitherto, has not been recorded from the state. This subspecies probably occurs south to the White Mountain region in the Canadian zone.—NORMAN A. PREBLE, *Wakefield, Massachusetts.*

SOREX LONGIROSTRIS LONGIROSTRIS IN AUGUSTA COUNTY, VIRGINIA

Analyses of the contents of a series of opossum stomachs collected this past winter (1937) by U. S. Forest Service game technicians on the Big Levels Game Refuge, George Washington National Forest, Augusta County, Virginia, have established with certainty the presence of *Sorex longirostris longirostris* in the western mountain sector of Virginia. A complete specimen of this uncommonly collected shrew was taken from the stomach of an opossum secured January 13, 1937. Identification was verified by Dr. H. H. T.

Jackson, of the Biological Survey. The record represents a westward extension of range for this subspecies of perhaps 50 miles or more, and adds materially to our knowledge of its distribution, reducing appreciably the gap between the eastern and western boundaries of the previously known range of the animal.—James A Bruce, *U. S. Biological Survey, Washington, D. C.*

CRYPTOTIS PARVA IN CENTRAL NEW YORK

In view of the scarcity of records for this species in central New York, attention may be called to the presence of a skull of the little shrew (*Cryptotis parva*) in the pellet of a Great Horned Owl (*Bubo virginianus*), collected at Connecticut Hill, near Ithaca, April 6, 1935, by R. Cameron of the New York Conservation Department. The pellets were being examined for that department as a part of its Ruffed Grouse Investigation. The identification was made after comparison with specimens in the Biological Survey collection, and was verified by A. L. Nelson, of this bureau. The specimen is retained in the collection of the Biological Survey.—John C. Jones, *Bureau of Biological Survey, Washington, D. C.*

SEX DICHROMATISM IN NOCTILIO

Marked difference in the coloration of the two sexes is rare in bats. One of the most familiar examples is that of the red bat (*Lasiurus borealis*), in which the males are bright chestnut red while the females are much duller in tone with a frosting of whitish over the body. Lately, while examining a series of hare-lipped bats (*Noctilio leporinus*) in the Museum of Comparative Zoology, sent in formalin by Major Herbert C. Clark, from Panama, I was struck by the fact that all of the adult males were deep rufous above, brighter orange rufous below, while all of the females were paler and lacked the rufous tints altogether, being olive brown above, paling into clearer yellowish or yellowish buff below. This led to the examination of other specimens, including a male skin from Trinidad and a series of 29 skins from Igarapé de Piaba, Rio Amazonas, Brazil. The result was the same; all the bright rufous individuals were adult males, while the females were without exception dull olive brown above, and more buffy brown below. Other skins from Sta. Lucia, St. Vincent, and Martinique, in the Lesser Antilles, are uniformly drab in color above, paler to grayish white below, lacking the brown tint of the Amazonian series. Although some are marked males, they are apparently all females; this is, however, difficult to determine in the dried skins. If correctly sexed, it may be that the rufous condition is not attained by adults of the West Indian race.

Referring again to the lot sent by Major Clark, all 58 were collected on February 9, 1935, near Pacora, Rio Santa, and comprise, apparently, a sample from a single colony. Of the lot, 8 are adult rufous males and the remaining 50, adult brownish-and-buff females. Thirty of the latter contained each a single large embryo and there was a single newly born young; the remainder were non-pregnant females. Evidently, then, there is at least only partial segregation of the sexes at the breeding time, the males and non-pregnant females remaining with the others of the colony. I have found no record of the time of year when the young are born, nor of the number (here only one) brought forth at a birth; hence this series helps to throw light on these points.—Glover M. Allen, *Museum of Comparative Zoology, Cambridge, Massachusetts.*

A HOARY BAT FAMILY

Three hoary bats (*Nycteris cinerea*), a family consisting of a female and two nursing young (C.M.N.H. nos. 2520-2), were found on the ground in Denver, Colorado, June 25, 1936, and brought to The Colorado Museum of Natural History, with the young clinging tightly to the mother's teats. She had evidently been grounded by the weight of the

young. The combined weight of the young was more than 25 per cent in excess of that of the female. The latter weighed 20.8 grams, and the two immature males, 13.87 and 14.12 grams respectively. It would be interesting to know how far the mother had been able to carry her heavy burden.—ALFRED M. BAILEY, *Colorado Museum of Natural History, Denver, Colorado.*

A RECORD OF TADARIDA MACROTIS FROM UTAH

A free-tailed bat, subsequently identified as *Tadarida macrotis*, was taken by me at Zion Lodge, Zion National Park, Utah, in August, 1928. This bat, a female was taken to the Museum of Vertebrate Zoology, Berkeley, California, for identification. The specimen, M. V. Z. no. 47083 (alcoholic), was then sent to the U. S. National Museum, where C. H. Shamel corroborated its earlier identification and indicated that it was the first Utah record for this species.—A. M. WOODBURY, *University of Utah, Salt Lake City, Utah.*

THE NORTHERN LONG-TAILED WEASEL IN NEW HAMPSHIRE

There are two unpublished records of *Mustela frenata occisor* (Bangs) in the collection of the New England Museum of Natural History. The specimens were collected by G. and V. D. Lowe on March 8, 1907, and November 18, 1906, respectively, at Randolph, New Hampshire. One specimen has been misplaced and the other mounted for exhibition. Measurements from the mounted animal are as follows: Total length, 461; tail vertebrae, 135; hindfoot, 46 mm.

The distribution of the race *occisor* has not been definitely ascertained, but it is a Canadian Zone species and doubtless replaces *noveboracensis* in the White Mountain region of New Hampshire, and in southern Maine.—NORMAN A. PREBLE, *73 Prospect Street, Wakefield, Massachusetts.*

STOATS MATING IN AUTUMN

On April 20, 1935, Mr. Jarkoff, collaborator of the Volga-Kama biological station for the study of fur animals and trapping, at Kazan, dissected a female stoat (*Mustela erminea*) that had died in the Kazan zoological garden, and found it to contain 11 embryos. He was informed that this animal had been kept during October, 1934, in an isolated cage and had been received by the zoo with a group of stoats in May.

In an endeavor to verify the possibility of the autumnal mating of stoats, the station and zoological garden obtained several of these animals during the autumn and winter of 1936–1937 and kept them in separate cages. Of these stoats only one female, received January 28, 1937, survived until the spring, and on May 11 it had an abortion.

Thus we discovered that *Mustela erminea*, like the marten and sable, has an autumnal or possibly a summer mating period. This is in accord with the data of Jarkoff, who in studying stoats in the wild during February and March, 1935, did not observe any change in behavior that would indicate the occurrence of mating activities.—V. I. TICHWINSKY AND N. D. GRIGORIEFF, *Volga-Kama Biological Station for Studying Fur Animals and Trapping, Kazan, U.S.S.R.*

A NOTE ON THE FOOT OF NOTHARCTUS

One of the most striking peculiarities of the lemurine foot (I am using the word lemurine in the widest sense) is found in the structure and mechanical action of the first metatarsal bone. This peculiarity consists in the elongation of the process known in human anatomy as the inferior angle (Cunningham), and called the peroneal process by Gregory, to such a degree that when the tendon of the peroneus longus is pulled upon by the contraction of the muscle, the dorsal side of the process is brought into firm contact

with the ventral side of the bases of metatarsals 2 and 3, thus pressing the bases of three bones together so as to form the apex of a resistant fork between the diverging first, and the two other metatarsals. The efficiency of this fork is usually increased by the development, on the dorsal edge of the elongated inferior angle, of a shallow but evident groove in the region where the ligament draws the angle against the under side of the second metatarsal.

This lemurine joint-strengthening system that involves interaction between the bases of the first and third matatarsals and the frequent development of a steadying groove on the inferior angle of the first metarsal, is more highly specialized than any other that is known among primates. I have seen it in representatives of the following recent genera: *Avahi, Chirogale, Daubentonia, Galago, Hapalemur, Lemur, Loris, Microcebus, Myoxicebus, Nycticebus, Perodicticus, Propithecus,* and *Tarsius.*

The presence of this structure in animals so different from each other as *Tarsius, Nycticebus* and *Propithecus,* would of itself suggest that the modification is a very old one. Confirmation of this idea has come through the kindness of Dr. Gregory and Mr. Raven who lent me the basal part of a left first metatarsal of *Notharctus* with its articular surface in a state of perfect preservation. So exactly does this fossil resemble the corresponding part of Recent lemurs that, except for a slightly too great robustness, it can be perfectly fitted into the foot of *Lemur mongoz* no. 49947 U. S. N. M. The peculiar groove for the reception of the shaft of metatarsal 2 is normally developed, and so also is the elongated tip of the process that impinges on metatarsal 3. This fragment shows positively, as Dr. Gregory's description and figure of the foot of *Notharctus osborni* (Mem. Amer. Mus. Nat. Hist., n.s., vol. 3, pp. 102–103, pl. 31, fig. 1, 1920) had led me to expect, that the most extreme known specialization of the primate grasping hallux had become "modernized" as long ago as the Eocene period—a fact of much theoretical interest because of its bearing on questions of relationship and descent within the primate group. —Gerrit S. Miller, Jr., *National Museum, Washington, D. C.*

TIGER-LION HYBRIDS

During a visit to the zoological garden at Dresden, Germany, I was very much interested to see a lively, playful family of young tiger-lion hybrids. They were the offspring of a male tiger and a lioness, and were then (1931) one-third grown. They were more like the tiger in the pattern of their coat. This was the second or third family of the same pair. Dr. W. Meise of Dresden wrote me that there is a similar hybrid family in the zoological garden at Munich, but with the sex of the parents reversed, lion and tigress. These hybrids at first have the stripes of the tiger and also the spots of young lions, which latter may have been true of the Dresden family at an earlier age. Dr. Meise added that the voice of the Munich hybrids resembled the grunting of the tiger, but more drawn out, like the lion's, thus somewhat resembling the voice of the leopard.—C. W. G. Eifrig, *River Forest, Illinois.*

CHANGE OF NAME OF SCIURUS CAROLINENSIS MINUTUS BAILEY

Dr. John Eric Hill, of the American Museum of Natural history, has kindly called my attention to the preoccupation of the name *Sciurus carolinensis minutus* Bailey (Bailey Museum and Library of Natural History, Bull. no. 12, January 15, 1937) by *Sciurus minutus* du Chaillu (Proc. British Soc. Nat. Hist., vol. 7, p. 366, 1861). I therefore wish to change the name *Sciurus carolinensis minutus* Bailey to *Sciurus carolinensis matecumbei,* the key gray squirrel.—Harold H. Bailey, *820 Alhambra Circle, Coral Gables, Florida.*

THE EAR MUSCLES OF THE WOODCHUCK

Seton, in his "Lives of Game Animals" (vol. 4, p. 302) writes of the ear of the woodchuck; "The following by Godman is important if sustained by fuller investigations: 'The ear is provided with a muscular apparatus by which the upper portion is brought down and the sides of the lower portion are so accurately pressed against each other as effectually to exclude the smallest particles of dirt or dust'." While studying the head musculature of the woodchuck, I investigated the possibility of such a mechanism.

The opening of the external auditory meatus is sufficiently blocked by the cartilaginous fold of the subhelix to prevent large particles from entering the ear. The skin over this and over adjoining parts of the inner surface of the external ear is well provided with stiff hairs, which extrude fine particles. In my specimen the hairs were well covered with dust.

The retro-auricular musculature is moderately well developed and appears as two layers, both of which arise from the mid-dorsal fascia of the head. The superficial layer, the auriculo-occipitalis muscle, is much more extensive. Only the more lateral fibers of this reach the pinna, on the anterior part of its medial or dorsal surface. The deeper layer consists of two slips, the fibers of which supply the rest of the dorsal surface. These muscle fibers are, of course, elevators of the ear. Also opposing depression of the ear are a few stout connective-tissue fibers possibly with some admixture of muscle fibers, which arise from the lambdoidal crest.

I was unable to find any muscular tissue that could approximate helix and antihelix, as Godman suggested. Along the posterior border and on the posterior part of the lateral, or ventral, surface of the ear, however, was a thin sheet of muscle that conceivably could aid in the approximation of the antitragus to the tragus, although this might only pucker the skin. Some of these fibers had origin from the parotid fascia, which is very tough and forms a good anchorage. A definite, although fine, band of muscle, apparently a part of this same sheet, arises from the most posterior part of the parotid fascia. It would tend to pull the base of the ear backward.

Next, there was a fine band of muscle and connective tissue running from the anterior border of the base of the ear to the masseteric fascia over the head of the mandible which would oppose the action of the last-mentioned muscle.

Last, the stoutest muscle of all arose from the temporal bone beneath, and was inserted into the cartilage of the subhelix above. Stimulation of this muscle would so depress the subhelix as to decrease the size of the external opening of the ear.

From the foregoing it would seem that only the subhelix muscle could answer the purpose suggested by Godman. Indeed, it is unnecessary to look for a more elaborate protective mechanism than the hairs and the size of the subhelix itself. From the size of the muscles in general, one might also say that movement of the ear is limited.—GORDON W. JONES, *Wilderness, Virginia.*

CYNOMYS LUDOVICIANUS LUDOVICIANUS FROM THE PLEISTOCENE OF KANSAS

As there are few records of rodents from the Pleistocene of Kansas, it is important to place on record all new discoveries for which the horizons are known. During the summer of 1936, while Dr. M. K. Elias, of the Kansas Geological Survey was making a study of the Pleistocene deposits in northwestern Kansas, he collected a part of a skull of a prairie-dog, (*Cynomys l. ludovicianus*), with a complete brain cast. This is no. 3968 K.U.M.V.P. The locality is 1.65 miles north and one-fourth mile west of Kanona, Decatur County, Kansas. The skull was taken 2 feet above the base of the red clay (Loveland? clay). Above the skull was a yellowish-buff loess that contained terrestrial gastropods. The maxillary tooth row is 17.3 mm. in length and the dentition corresponds

in all details with that of the prairie-dog now found in Kansas, although this is the first fossil record of this species for the state.—CLAUDE W. HIBBARD, *Museum of Vertebrate Paleontology, University of Kansas, Lawrence, Kansas.*

MUSKRAT SEX-RATIOS IN UTAH

To prevent damage to the dikes and spillboxes at the Bear River Migratory Bird Refuge, Utah, it has been necessary to control the muskrats near these structures by granting permits to local trappers to catch them in certain areas. Through the coöperation of Joseph Hansen, trapper, and G. E. Mushback and V. T. Wilson, refuge officials, there were obtained the records of sex-ratios and pregnancies of 1556 of the 1589 muskrats caught during the periods from October 16 to December 12, 1936, and March 12 to April 7, 1937. The subspecies of muskrat in this region presumably is *Ondatra zibethica osoyoosensis* (Lord).

The trapping was as intensive as possible along dikes and artificial nesting banks, chiefly in unit 2 of the refuge, which has an area of approximately 5000 acres. Vegetative type areas in this unit are roughly as follows: Submerged aquatics (*Potamogeton* spp., *Ruppia* spp., and *Chara*), 3000 acres; emergent vegetation (*Scirpus paludosus*, *S. occidentalis*, and *Typha* spp.), 1500 acres; and *Distichilis spicata*, 500 acres. In general, muskrat signs, such as houses, feeding stations, bank dens, and canals, were adjacent to the strips of *S. occidentalis* and *Typha*, which extend along channels through the unit and total roughly 400 acres in area.

The muskrats were sexed by Mr. Hansen on the basis of external genitilia. These were checked at intervals by dissection and found to be correct in every instance. Pregnancies were determined by field dissection of carcasses after skinning.

The data were organized on the basis of 10-day units, as follows:

PERIOD	NO. MALES	NO. FEMALES	TOTAL	SEX-RATIO	PREGNANCIES	EXAMINATIONS
1936						
Oct. 10–25	80	99	179	44.5-55.5	None	20
Oct. 26–Nov. 4	131	151	282	46.5-53.5	None	10
Nov. 5–14	109	118	227	48.0-52.0		
Nov. 15–24	118	108	226	52.0-48.0		
Nov. 25–Dec. 4	37	43	80	46.5-53.5		
Dec. 5–13	35	36	71	49.5-50.5		
Totals	510	555	1,065	48.0-52.0	None	30
1937						
Mar. 12–21	109	72	181	60.5-39.5	None	13
Mar. 22–31	171	111	282	60.5-39.5	5*	25
April 1–7	17	11	28	61.0-39.0	1†	2
Totals	297	194	491	60.5-39.5	6	40

* 2 of 5 and 3 of 8.

† 1 of 6.

Analysis of the data indicates the following: 1. Intensive trapping in the fall resulted in a sex-ratio of 48 males to 52 females in a sample of 1065 muskrats. 2. Intensive trapping in the spring, in the same areas, resulted in a sex-ratio of 60.5 males to 39.5 females in a sample of 491 muskrats. 3. No pregnancies were found in muskrats trapped after October 15. 4. Pregnancies were found in muskrats during the last 10 days in March. 5. During both trapping periods the sex-ratios remained nearly constant.

These data are of interest in that they bear out statements by trappers that spring trapping yields a larger percentage of males than fall trapping. It is of further interest that Mr. Hansen stated that the first few nights of a set usually yield males rather than females, so that by trapping the same area lightly several times he could raise the percentage of males higher than shown by this intensive trapping.—WILLIAM H. MARSHALL—*Bureau of Biological Survey, Brigham City, Utah.*

A YELLOW-HAIRED PORCUPINE BORN IN CAPTIVITY

In the northern part of the city of Lawrence, Kansas, is a small zoo, known as Green's Lake, privately owned and open to the public. Among other animals in captivity there are three adult yellow-haired porcupines (*Erethizon epixanthum epixanthum*), formerly of unknown sex. On May 29, a young porcupine was discovered in the cage, and when weighed and measured two days later, it was found to be a female, measuring 9 inches from snout to tip of tail as it stood in a natural position, and weighing exactly one pound. The hair was black and quite thin, especially along the back; the quills also were quite few in number, and were white, tipped with black. It is not only possible but probable that the young animal had remained in the cage unnoticed for several days, but the date of birth can be set quite accurately within the last week in May.—JAMES M. SPRAGUE, *Museum of Birds and Mammals, Lawrence, Kansas.*

MOOSE RECORDS FOR VERMONT

Since reporting the presence of moose (*Alces americana*) in western Massachusetts (Warfel, Jour. Mamm. vol. 18, 1937), a well authenticated record of this animal has been received from Vermont, in the town of Shaftsbury, 15 miles north of the Massachusetts-Vermont boundary. This individual was seen and heard by several persons living in that region, and was photographed October 23, 1936, by Harold MacDonald, a resident of South Shaftsbury.

As has been generally true of the whole of western New England, moose have been considered as extinct in this region for many years, and very little has been recorded concerning them in Vermont at any time. Zadock Thompson (Natural History of Vermont, 2nd Ed. 1853, Burlington), writing in 1843, stated that they had been present in considerable numbers in early times and were one of the important food items of the colonists, but that by that date they had been "exterminated from all portions of the state excepting the County of Essex in the northeastern part." Several were killed in that county in the winters of 1840–1841. J. W. Titcomb (Animal Life of Vermont. The Vermonter, vol. 5, no. 11, June, 1901), cited 3 killed in Essex County, 2 in 1899 and 1 in 1900. He stated that there were possibly 3 or 4 moose left in the state at the time he was writing. He also pointed out that they were protected by law, and had been since 1876.

Russel P. Hunter, Director of Fish and Game Service in Vermont, has informed me that in 1922 an injured specimen was killed by a game warden in Windham County, which is the extreme southeastern county. In addition to the record for 1936 cited above, 3 other records have been received by him for that year. One reported from Marshfield, Washington County, was well authenticated.

Where these animals have come from is largely a matter for conjecture. Certain facts are available, however, to explain their presence in their respective localities. The records for the southern Vermont counties can probably be explained by the releases mentioned by Warfel (ibid.). G. G. Goodwin (The Mammals of Connecticut, Pub. Doc. No. 47, Bull. No. 53, Hartford) also explained the presence of a moose at Litchfield, Connecticut, as probably being from the same source. The Marshfield record probably originated from Essex County, since these two regions are in the same general region of the state.—H. E. WARFEL, *Massachusetts State College, Amherst, Massachusetts.*

REVIEW

Bennitt, Rudolf, and Werner O. Nagel. A SURVEY OF THE RESIDENT GAME AND FURBEARERS OF MISSOURI. The University of Missouri Studies, vol. 12, no. 2, April 1, 1937. Columbia, Missouri. 215 pp.

Game surveys have become a standard symptom of our discontent with the husbandry of wildlife. In state after state we grope for a formula for conservation, and find there is none. Moreover, we find that even the most elementary facts out of which to build one are *not obtainable* in conservation offices. Hence we order a re-appraisal of the problem, and call it a game survey.

Not every survey has set sail under such happy auspices, or arrived at so meaty a publication as Bennitt and Nagel's "Game and Furbearers of Missouri." The University furnished the skilled personnel, the National Park Service the funds for a year's field work, and a group of private citizens paid the printer. The State Conservation Department was originally a party to the enterprise, but does not appear as co-sponsor of the report. This is regrettable. One could feel more confidence in the future of wildlife administration if more states participated in the critical analysis of their own wildlife policies.

The present report is not only a contribution to conservation, but can well be bracketed with Widmann's "Birds of Missouri" and Sauer's "Geography of the Ozarks" as a contribution to the natural history of the state. The authors, however, do not acknowledge their debt to Sauer.

Their findings present a gloomy picture of the status of Missouri wildlife. At least 5 species are headed for extermination within the state; ruffed grouse, prairie chicken, wild turkey, otter, beaver. No single species is found to be definitely increasing except the crow. Even the cottontail is reported as decreasing, at least temporarily. Surprisingly enough, the timber wolf is considered as in no immediate danger. Opossum, squirrel, skunk, and dove are reported as stabilized at a fairly high population level. The wild turkey is threatened not only by decreasing numbers, but by progressive dilution of the native stock through propagation and release of mongrel strains at state expense. The persistent failure of these mongrel birds has recently led to real efforts to improve their quality.

The Missouri survey is unique in supporting its appraisal of each species by a statewide census. In some species the census is derived from a well-selected system of measured samples; in others by computing the "breeding reserve" necessary to produce the annual take or kill. Such computation entails the use of assumed values for other mortality factors, and it ignores possible non-breeders, but despite its crudeness it has, I think, a definite value. It plants the idea that wildlife crops are a measurable and predictable product of the environment.

Bennitt and Nagel advance the rather novel speculation that the housecat may account for the mysterious disappearance of the ruffed grouse in the Ozarks. There is a mystery here. Even Iowa has more grouse left than Missouri, despite her radically greater shrinkage in coverts. If we can postulate a radically higher population of feral cats in Missouri, this may be a valid speculation. Our authors give Missouri a population of 680,000 hunting cats. Isn't it time for someone to produce an ecological monograph on so abundant and important a mammal?

The report displays a thoroughly modern view of most questions of wildlife ecology, with one curious exception: It asserts (p. 181), that "the only reliable way to find out the food habits of an entire species is to use a large number of specimens, widely distributed geographically and taken at all times of year . . . local field observations are no fair indication of the good or harm done."

Such scattered sampling is certainly a good way to get the average of a notoriously

variable phenomenon, but is it averages we need? To my mind the really valuable thing is to *define the conditions* which cause food habits to vary. This knowledge has come *only* from the Stoddard-Errington type of local study. Scattered sampling never did and never can explain variation, because the local conditions are not known.

Considering their vast range of subject-matter, our authors trip over few errors of fact, and some of these are debatable. Tularemia, in their view, is a newly imported disease. I think the consensus of evidence supports the view that it is merely newly discovered. Bobcats, in their view, do not overlap their individual territories. My impression is the opposite.

The physical presentation of the data leaves little to be desired. Of a great number of charts, tables, and maps, I found only one undecipherable. One serious criticism can be offered: The report contains no index. There is only one worse fault, and that is a poor index.

Everything considered, I regard the Missouri Survey as the outstanding increment of the year to the growing literature of wildlife management. A hint to book collectors in the field of natural history, and to professional wildlife managers: Get a copy while one is available. But aside from the merits of the report, where does it lead us on the question of how to get conservation? To the same old dead end: Wildlife can be built up by building up the environment, but who will do it? Public agencies want to, but can't. Private landowners can, but do not want to.—ALDO LEOPOLD.

LIST OF RECENT LITERATURE

[Conducted by Arthur H. Howell, Remington Kellogg, and Gerrit S. Miller, Jr.]

AFANASJEV, A., AND N. ZOLOTAREV. Contribution to the systematics and distribution of the red wolf. Izvestiia Akademii Nauk USSR, Otdelenie Matematicheskikh i Estestvennykh Nauk (Bull. Acad. Sci. URSS Cl. Sci. Math. et Nat.), 1935, no. 3, pp. 425–429. 1935. (In Russian with English summary.)

ALI, SALIM. The preservation of wild life in India. No. 8. Hyderabad State. Jour. Bombay Nat. Hist. Soc., vol. 38, no. 2, pp. 231–240. December 1, 1935.

ALLEN, GLOVER M. Two new races of Indian bats. Records Indian Mus., vol. 38, pt. 3, pp. 343–346. September, 1936. (New: *Pteropus hypomelanus maris, Hipposideros larvatus grandis.*)

AMEGHINO, FLORENTINO. Observaciones generales sobre el órden de mamíferos estinguidos sud-americanos llamados toxodontes (*Toxodontia*) y sinópsis de los géneros y especies hasta ahora conocidos. Anales Museo de la Plata, Entrega Especial, pp. 66. 1936. (Reprint.)

ANDIA, ERNESTO. Sobre una mandíbula de Megatherium procedente de Santa Fe. Rev. Argentina Paleontol. y Antropol. Ameghinia, vol. 1, no. 4, pp. 127–219, pls. 3, fig. 1. October 15, 1935.

AOKI, BUN'ICHIRO, and RYÔ TANAKA. Biometrical studies on *Rattus losea* (Swinhoe) 1. Jour. Soc. Trop. Agric., Taiwan, vol. 6, no. 3, pp. 475–494, figs. 9. November, 1934. (In Japanese with English summary.)

ARAMBOURG, CAMILLE. Mammifères miocènes du Turkana (Afrique Orientale). Ann. Paléontol., Paris, vol. 22, nos. 3–4, pp. 121–147, pls. 2, figs. 5. March, 1934. (New: *Pliohyrax championi, Listriodon jeanneli, Dorcatherium chappuisi.*)

BANKS, E. A popular account of the mammals of Borneo. Jour. Malayan Branch Roy. Asiatic Soc., Singapore, vol. 9, no. 2, pp. 1–139, map, pls. 9. November, 1931.

BARABASH, I. I., and S. KLUMOV. The Pacific Ocean form of white whale. Biulleten'

rybnogo Khoziaistvo SSSR (Sea Fishery Economics in USSR), Moscou, no. 11, p. 24. 1935. (In Russian. New: *Delphinapterus dorofeevi*.)

BASTIN, A. Sur la présence de la l'hippipotame quaternaire dans le Nord-Est de la France. Ann. Soc. Géol. du Nord, Lille, vol. 58, pp. 92–118, map, pl. 6, fig. 1. 1933.

BAUDOUIN, MARCEL. Echouement d'un Delphinorhynque (*Delphinorhynchus rostratus*) sur la plage de la Pège, en Saint-Hilaire-de-Riez (Vendée). Bull. Soc. Sci. Nat. Ouest France, Nantes, ser. 4, vol. 9, nos. 1–4, pp. 25–28. March 31, 1930.

BECHTHOLD, GERHARD. Einige neue Unterarten asiatischer Herpestiden. Zeitschr. f. Säugetierkunde, vol. 11, no. 1, pp. 149–153. March 13, 1936. (New: *Herpestes griseus montanus, H. brachyurus javanensis, H. urva annamensis, H. u. formosanus, H. u. sinensis*.)

BIESE, WALTER. Das geologische Alter der Vielfrassreste. Zeitschr. f. Säugetierkunde, vol. 11, pp. 319–320, pls. 16. March 13, 1936.

BOHLIN, BIRGER. Cavicornier der Hipparion-Fauna Nord-Chinas. Palaeont. Sinica (Nat. Geol. Surv. China), vol. C 9, no. 4, pp. 1–166, pls. 20, figs. 142. 1936. (New: *Plesiaddax ? minor, ? Tragoreas lagrelii, ? Protoryx planifrons, ? P. shansiensis, Paraprotoryx, P. minor, P. killgusi, Prosinotragus, P. tenuicornis, Sinotragus, S. wimani*.)

BOYD, MARK F. The occurrence of the American bison in Alabama and Florida. Science, n.s., vol. 84, no. 2174, p. 203. August 28, 1936. (Mentioned by Marcos Delgado in 1686 as seen in Jackson Co., northwest of Marianna, Fla., and Little Choctawhatchee River, Houston Co., Ala.)

BRAMBELL, F. W. ROGERS, and I. W. ROWLANDS. Reproduction of the bank vole (*Evotomys glareolus* Schreber). 1. The oestrous cycle of the female. Philos. Trans. Roy. Soc., London, ser. B, no. 531, vol. 226, pp. 71–97, pls. 10–11. March 18, 1936.

BRUNNER, GEORG. Das Grubenloch bei Oberklausen. Eine spätdiluviale Fauna mit *Ursus arctos* L. und *Gulo gulo* L. Zeitschr. f. Säugetierkunde, vol. 11, pp. 257–276, figs. 24, pls. 8. March 13, 1936.

BURSCH, F. C. The Pleistocene human skull from Hengelo. III. Archaeological part. Proc. Sect. Sci., Kon. Akad. Wetensch. te Amsterdam, vol. 39, no. 1, pp. 83–87, figs. 9. 1936.

CABRERA, ANGEL. Sinopsis de los caminos [= canidos] Argentinos. Rev. Centro. Nacion. Ing. Agron. y Centro. Estud. Agron., Buenos Aires, vol. 25, no. 145, pp. 489–501. 1932.

———— A propósito de guanacos fósiles. La Semana Médica, vol. 40, no. 2037, pp. 364–365. January 26, 1933.

CARCELLES, ALBERTO. Tres viajes a los mares antárticos. Breves observaciones biológicas y económicas sobre cetáceos. Physis, Buenos Aires, vol. 11, no. 38, pp. 48–81, figs. 9. December 31, 1932.

CHASEN, F. N. On mammals from Siam. Jour. Siam Soc. Nat. Hist., Supplement, vol. 10, no. 1, pp. 31–57, tables. December, 1935.

CLIFF, EDWARD P. The beaver—empire builder and conservationist. Utah Juniper, Logan, Utah, vol. 7, pp. 23–26, illus. 1936.

COHRS, P., and K. M. SCHNEIDER. Kryptorchismus beim Löwen und Hypoplasie der Genitalorgane mit Kryptorchismus beim Edelhirsch. Zool. Garten, Leipzig, n. F, vol. 8, nos. 7–9, pp. 201–208, figs. 9. 1936.

COLBERT, EDWIN H. Was the extinct giraffe (Sivatherium) known to the early Sumerians? Amer. Anthropol., vol. 38, no. 4, pp. 605–608, pls. 21–22. October–December, 1936. (Apparently.)

COLBERT, EDWIN H. Notice of a new genus and species of artiodactyl from the upper Eocene of Wyoming. Amer. Jour. Sci., ser. 5, vol. 33, no. 198, pp. 473–474. June, 1937. (New: *Brachyhyops, B. wyomingensis.*)

COLYER, FRANK. Variations and diseases of the teeth of animals. London: John Bale, Sons & Danielsson, Ltd., pp. viii + 750, figs. 1007. 1936.

COOLIDGE, HAROLD J., JR. Zoological results of the George Vanderbilt African Expedition of 1934. Pt. 4. Notes on four gorillas from the Sanga River region. Proc. Acad. Nat. Sci. Philadelphia, vol. 88, pp. 479–501, pls. 2, fig. 1. October 23, 1936.

COOPER, C. FORSTER. Palaeocene mammals. Nature, London, vol. 140, no. 3532, pp. 46–47, fig. 1. July 10, 1937. (Review of W. D. Matthew, 1937, Palaeocene faunas of the San Juan Basin, New Mexico.)

COTTON, W. B. Note on the giant-forest hog (*Hylochoerus meinertzhageni*). Proc. Zool. Soc. London for 1936, no. 3, pp. 687–688. September, 1936.

DAMMERMAN, K. W. Fauna Buruana. Mammalia. Treubia, Buitenzorg, Suppl., vol. 7, no. 4, pp. 149–164. December, 1929.

DANILOWITSCH, A. P. Über die Verbreitung einiger Arten der familie Muscardinidae in der U. d. S. S. R. Folia Zool. et Hydrobiol., Riga, vol. 9, no. 1, pp. 61–62. May 23, 1936.

DAVIS, WILLIAM B. Young of the brush rabbit, Sylvilagus bachmani. Murrelet, Seattle, Wash., vol. 17, nos. 2–3, pp. 36–40, illus. November 14, 1936

DEGERBØL, MAGNUS. On Mus musculus spicilegus Pet. in Denmark. Vidensk. Meddel. Dansk naturhist. For. København, vol. 99, pp. 233–238. February 17, 1936.

DENT, G. British wild cat. Notes on status in Scotland. Jour. Soc. Preservation of Fauna of Empire, Hertford, n.s., pt. 26, pp. 48–51. September, 1935.

DUELO, L. TRELLES. Restos fosilizados de un manati extinguido del periodo Oligoceno inferior. Mem. Soc. Cubana Hist. Nat., Habana, vol. 9, no. 4, pp. 269–270. January, 1936.

DURRANT, STEPHEN D. A new gopher from Antelope Island, Great Salt Lake, Utah. Bull. Univ. Utah, vol. 27, no. 2, pp. 1–4, figs. 2. October 3, 1936. (New: *Thomomys bottae nesophilus.*)

DURYMANOVA-SAVIK, N. P. Some observations on the character of food of some rodents. Izvestiia Biologicheskogo Nauchno-Issledovatel'skogo Instituta pri Permakom Gosudarstvennom Universitete (Bull. Inst. recherches biol. Univ. Perm), vol. 10, no. 3, pp. 101–113. 1936. (In Russian with English summary.)

ECKSTEIN, KARL. Etwas über forstlich beachtenswerte Mäuse. Allg. Forst- u. Jagd-Zeitg., Frankfurt a. M., vol. 112, no. 1, pp. 23–26, fig. 1. January, 1936.

EMEL'IANOV, A. A. (YEMELIANOF, A. A.) A brief preliminary list of mammals inhabiting the reserve ground of the mountain Taiga station of the Far Eastern Branch of the Academy of Sciences, USSR. Trudy Gornotaezhnoĭ Stantsii Dal'nevostochnogo Filiala Akademii Nauk SSSR (Trans. Taiga Station of the Far Eastern Branch Acad. Sci., vol. 1, pp. 265–266. 1936. (In Russian with English summary.)

FETISOV, A. S. Biological observations on the Transbaikal tolai hare *Lepus tolai tolai* Pallas. Izvestiia Vostochnosibirskogo Sel'skokhoziaistvennoge Instituta (Bull. Inst. Agric. East Siberia), vol. 1, pp. 138–148. 1935. (In Russian.)

FINLAYSON, H. H. On mammals from the Dawson and Fitzroy Valleys, Central Coastal Queensland. Pt. 2. Trans. and Proc. Roy. Soc. S. Australia, Adelaide, vol. 58, pp. 218–231. December 22, 1934.

——— On mammals from the Lake Eyre basin. Pt. 2. The Peramelidae. Trans.

and Proc. Roy. Soc. S. Australia, Adelaide, vol. 59, pp. 227–236, fig. 1. December 23, 1935.

FLEAY, DAVID. Observations on the birth of a wallaby. Australian Zool., Sidney, vol. 8, pt. 3, pp. 153–155, pl. 1. June 29, 1936. (*Setonix brachyurus.*)

FLEROV, K. K. The Turkestan stag or Hangul. Trudy Kirgizskoi kompleksnoi ekspeditsii, 1932–1933, vol. 10, pp. 315–343, figs. 11, pl. 1. 1935. (In Russian.)

FLORSCHÜTZ, F., and I. M., VAN DER VLERK. The Pleistocene human skull from Hengelo. I. Geological-palaeontological part. Proc. Sect. Sci., Kon. Akad. Wetensch. te Amsterdam, vol. 39, no. 1, pp. 76–80, figs. 5. 1936.

FRASER, F. C. Vestigial teeth in specimens of Cuvier's whale (*Ziphius cavirostris*) stranded on the Scottish Coast. Scottish Nat., no. 222, pp. 153–157, figs. 3. November–December, 1936.

FRENGUELLI, JOAQUÍN. A propósito del género "Ctenomys." Physis, Buenos Aires, vol. 11, no. 38, pp. 143–144. December 31, 1932.

FRIANT, MADELEINE. Interprétation des dents jugales chez les Lonchérinés. Vidensk. Meddel. Dansk Naturhist. For. Köbenhavn, vol. 99, pp. 261–266, figs. 3. March 30, 1936.

———— Les premiers stades du développement superficiel du neopallium et du rhinencéphale chez les Pinnipèdes. Bull. Mus. Nat. d'Hist. Nat., Paris, ser. 2, vol. 8, no. 5, pp. 374–384, figs. 8. October, 1936.

FRICK, CHILDS. Horned ruminants of North America. Bull. Amer. Mus. Nat. Hist., New York, vol. 69, pp. xxviii + 669, figs. 68. March 31, 1937. (New: *Procranioceras, Cranioceras* (*Procranioceras*) *skinneri, Cranioceras granti, C. mefferdi, C. dakotensis, C. kinseyi, C. pawniensis, C. clarendonensis, Rakomeryx, Rakomeryx raki, R. jorakianus, R. yermonensis, R. gazini, Subdromeryx, S. scotti, S. wilsoni, Dromeryx pawniensis, Bouromeryx, B. milleri, B. submilleri, B. nebrascensis, B. supernebrascensis,* (?) *B. pseudonebrascensis, B. pawniensis, Barbouromeryx* for *Dromeryx trigonocorneus* Barbour & Schultz, *Probarbouromeryx, P. sweeti, Protobarbouromeryx, P. marslandensis, Malthomeryx, M. matthewi, Yumaceras, Y. figginsi, Y. falkenbachi, Aletomeryx lugni, A. marslandensis, Sinclairomeryx, S. sinclairi, S. tedi, Procoileus, P. edensis, Cervus lascrucensis, C. aguangae, Odocoileus sheridanus, O. cascensis, O. cooki, Cervalces alaskensis, Blastocerus blicki, Palaeoodocoileus salinae, Longirostromeryx, L. merriami, L. serpentis, L. novomexicanus, L. clarendonensis,* (?) *L. blicki, Blastomeryx mefferdi, Blastomeryx gemmifer valentinensis, B. francesca, B. francescita, Parablastomeryx, P. gregorii,* (?) *P. galushi, Pseudoparablastomeryx, Parablastomeryx* (*Pseudoparablastomeryx*) *scotti, Pseudoblastomeryx, P. falkenbachi, P. schultzi,* (?) *P. marsa, Ramoceros* for *Merycodus osborni* Matthew, *R. ramosus quadratus, R. hitchcockensis, Paramoceros, Ramoceros* (*Paramoceros*) *marthae, R.* (*P.*) *howardae, R.* (*P.*) *kansanus, R.* (*P.*) *palmatus, R.* (*P.*) *brevicornis, Merriamoceros* for *Merycodus* (?) *coronatus* Merriam, *Subcosoryx, Cosoryx* (*Subcosoryx*) *cerroensis, Cosoryx ilfonsensis, Cosoryx furcatus sternbergi, C. f. mooki, Paracosoryx, Cosoryx* (*Paracosoryx*) *alticornis, C.* (*P.*) *furlongi, C.* (*P.*) *wilsoni, Subparacosoryx, Cosoryx* (*Subparacosoryx*) *savaronis, C.* (*P.*) *dawesensis, Meryceros, M. major, M. crucensis, M. nenzelensis, M. warreni johnsoni, M. joraki, Submeryceros, Meryceros* (*Submeryceros*) *crucianus, Osbornoceros, O. osborni, Plioceros, P. blicki, P. floblairi, P. dehlini, Texoceros, T. guymonensis,* (?) *T. minorei,* (?) *T. vaughani,* (?) *T. edensis, Stockoceros, S. conklingi, Capromeryx gidleyi, Hayoceros, H. falkenbachi, Saiga ricei, Ovis dalli kaiseni, O. dorshi,* (?) *Ovibos giganteus, Bos* (*Poëphagus*) *bunnelli,* (?) *Synthetoceras rileyi, Prosynthetoceras, P. francisi, P. siouxensis, P. s. dawesensis, Paratoceras, P. macadamsi, Leptomeryx minimus,* (?) *Hypertragulus minor,* (?) *H. dakotensis, Nanotragulus*

albanensis, N. lulli, Pseudoceras, P. skinneri, P. wilsoni, P. potteri, P. klausi, Rakomylus, R. raki.)

Fu, T. S. The squirrel of Sung-Shan and its vicinity. Bull. Fan Mem. Inst. Biol., vol. 6 (Zool.), no. 6, pp. 255–264. May 7, 1936.

Gagnebin, Elie. Ossements de Mammouth trouvés dans la moraine de Renens, près Lausanne et recensement des restes de Mammouths connus dans la région lémanique. Bull. Soc. Vaudoise Sci. Nat., Lausanne, vol. 58, no. 237, pp. 385–391. August 31, 1935.

Gerber, Ed. Verzeichnis der palaeontologischen Originalien und abgebildeten oder beschriebenen Arten im Naturhistorischen Museum Bern. Mitteil. Naturforsch. Ges. Bern, Jahre 1935, pp. 1–23. 1936.

——— Ueber neuere Murmeltierfunde aus dem bernischen Diluvium. Mitteil. Naturforsch. Ges. Bern, Jahre 1935, pp. 24–28, fig. 1. 1936.

Gerstell, Richard. The elk in Pennsylvania. Its extermination and reintroduction. Pennsylvania Game News, Harrisburg, vol. 7, no. 7, pp. 6–7, 26, illus. October, 1936.

Gethin, R. G. Pine marten visitor. Irish Nat. Jour., vol. 6, no. 6, pp. 145–146. November, 1936. (Said to be increasing in Ireland.)

Gladkov, N. A., and G. V. Nikolskij. Materialien zur Kenntnis der Säugetierfauna der mittleren und unteren Amu-Daria. Sbornik Trudov Gosudarstvennogo Zoologicheskogo Muzeia (Archiv. Mus. Zool. Univ. Moscou), no. 2, pp. 3–16. 1935. (In Russian with German summary.)

Goldman, E. A. A new kangaroo rat from Southwestern Arizona. Proc. Biol. Soc. Washington, vol. 50, pp. 75–76. June 22, 1937. (New: *Dipodomys merriami regillus.*)

——— A new puma from Texas. Proc. Biol. Soc. Washington, vol. 49, pp. 137–138. August 22, 1936. (New: *Felis concolor youngi.*)

Gourdon, Maurice. Note sur le Bouquetin des Pyrénées. Bull. Soc. Sci. Nat. Ouest France, Nantes, ser. 4, vol. 9, nos.1–4, pp. 60–69. 1929.

——— Note sur les petits Mammifères des Pyrénées. Bull. Soc. Sci. Nat. Ouest France, Nantes, ser. 4, vol. 10, nos. 1–4, pp. 15–29. April 30, 1931.

Gregory, William K. Habitus factors in the skeleton of fossil and recent mammals. Proc. Amer. Philos. Soc., vol. 76, no. 4, pp. 429–444, figs. 14. 1936.

Gromova, Vera. Über die Verbreitung des Moschusochsen (*Ovibos moschatus* Zimm.) in Osteuropa und Nordasien. Izvestiia Akademii Nauk SSSR. Otdelenie Matematicheskikh i Estestvennykh Nauk (Bull. Acad. Sci. URSS. Cl. Sci. Math. et Nat.), 1935, no. 1, pp. 101–114. 1935. (In Russian with German summary.)

——— Über einen Fund der Pleistozänen Säugetierfaune im Gouvernement Kostroma. Izvestiia Akademii Nauk SSSR, Otdelenie Matematicheskikh i Estestvennykh Nauk (Bull. Acad. Sci. URSS. Cl. Sci. Math. et Nat.), 1935, no. 3 pp. 455–476, pls. 2. 1935. (In Russian with German summary.)

——— Über neue Funde von *Bison priscus longicornis* mihi und über einen stark von der Norm abweichenden Schädel dieser Form. Trudy Paleozoologicheskogo Instituta Akademii Nauk SSSR (Trav. Inst. Paleozool. Acad. Sci. URSS), vol. 4, pp. 137–147, figs. 2, 1 folding table. 1935. (In Russian with German abridgement.)

——— Über die Reste des Merckschen Nashorns (*Rhinoceros merki* Jaeg.) von der unteren Wolga. Trudy Paleozoologicheskogo Instituta Akademii Nauk SSSR (Trav. Inst. Paléozool. Acad. Sci. URSS), vol. 4, pp. 91–136, figs. 4, pls. 3, 1 folding table. 1935. (In Russian with German summary.)

GUBERLET, JOHN E. Note on embryo porpoise. Murrelet, Seattle, Wash., vol. 17, nos. 1–2, p. 56. November 14, 1936. (*Lagenorhynchus obliquidens.*)

GÜHLER, U. Beitrag zur Geschichte von *Cervus* (*Rucervus*) *schomburgki* Blyth. Zeitschr. f. Säugetierkunde, vol. 11, no. 1, pp. 2–31. March 13, 1936.

HALTENORTH, THEODOR. Die verwandtschaftliche Stellung der Groskatzen zueinander. 1. Beschreibung der Schädelknochen. Zeitschr. f. Säugetierkunde, vol. 11 no. 1, pp. 32–104, pls. 21–46. March 13, 1936.

HANNA, JOHN G. Nature of dog bites. Jour. Amer. Med. Assoc., vol. 107, no. 15, p. 1239. October 10, 1936.

HARRINGTON, M. R. A new ground sloth den. The Masterkey, Southwest Mus. Los Angeles, vol. 10, no. 6, pp. 225–227, fig. 1. November, 1936. (Rampart cave, Grand Canyon, near Boulder City, Nevada.)

HARTMAN, NEWTON H. Photographs of some mammals, now or recently living in the Zoological Garden. Annual Report Zool. Soc. Philadelphia, for year ending February 29, 1932, pp. 22, illus. 1932.

HASSE, G. Wichelen préhistorique. 1re et 2e partie. Bull. Soc. Roy. Belge Anthrop. et Préhistorique, vol. 49, pp. 65–74; 1–19, figs. 13. 1934. (Mammal faunas; artifacts made from mammal bones.)

——— L'élan pré- et protohistorique. Comptes Rendus 2me Congres National des Sciences, Bruxelles, pp. 958–962, figs. 10. 1935. (*Alces.*)

HAUGHTON, S. H. The fossil Equidae of South Africa. Ann. S. African Mus., vol. 28, pt. 4, pp. 407–427, figs. 6. February, 1932. (New: *Equus sandwithi, Notohipparion, N. namaquense.*)

HAYWARD, C. LYNN. A bibliography of Utah mammalogy; including references to names and type localities applied to Utah mammals. Proc. Utah Acad. Sci., Arts, and Letters, vol. 13, pp. 121–146. 1936.

HECK, H. Bemerkungen über die Mähne der Urwildpferde. Zool. Garten, Leipzig, n. F., vol. 8, nos. 7–9, pp. 179–189, figs. 12. 1936.

HEINRICH, GERD. Ueber die von mir im Jahre 1935 in Bulgarien gesammelten Säugetiere. Izvestiia na Tsarskitie Prirodonauchni Instituti v Sofiia (Mitteil K. Naturwiss. Inst. Sofia-Bulgarien), vol. 9, pp. 33–48. 1936. (New: *Miniopterus schreibersii inexspectatus, Myotis mystacinus bulgaricus, Leuconoe capaccinii bureschi, Sciurus vulgaris balcanicus, S. v. rhodopensis, S. v. istrandjae, Microtus arvalis rhodopensis.*)

HELBING, H. Die Tertiären Wirbeltiere des Steinheimer Beckens. Teil V. Die Carnivoren des Steinheimer Beckens. A. Mustelidae. Palaeontographica, Stuttgart, Suppl. vol. 8, pp. 1–56, figs. 13, pls. 4. 1936.

HELLER, FLORIAN. Diaceratherium förstheimense n. sp., ein neuer Rhinocerotide aus dem Mainzer Becken. Senckenbergiana, vol. 15, nos. 5–6, pp. 295–302, figs. 6. December 29, 1933. (New: *Diaceratherium förstheimense.*)

——— Die Kleinsäugerreste aus dem Travertin des Biedermannschen Steinbruchs von Untertürkheim-Bad Cannstatt. Jahreshefte Ver. Vaterl. Naturk. Württemberg, Stuttgart, Jahre 90, pp. 20–30. 1934.

——— Amphilemur eocaenicus n. g. et n. sp., ein primitiver primate aus dem Mitteleozän des Geiseltales bei Halle a. S. Nova Acta Leopoldina, Abhandl. Kais. Leopold.-Carolin. Deutschen Akad. Naturforscher, Halle, vol. 2, no. 3, pp. 293–300, fig. 1. pl. 1. 1935. (New: *Amphilemur, A. eocaenicus.*)

——— Fledermäuse aus der eozänan Braunkohle des Geiseltales bei Halle a. S. Nova Acta Leopoldina Abhandl. Kais. Leopold.-Carolin. Deutschen Akad. Naturforscher, Halle, vol. 2, no. 3, pp. 301–314, pls. 3. 1935. (New: *Cecilionycteris, C. prisca.*)

HELLER, FLORIAN. Neue Beuteltierreste aus der mitteleozänen Braunkohle des Geiseltales. Nova Acta Leopoldina, Halle, n. F., vol. 4, no. 22, pp. 311–316, pl. 1. 1936. (New: *Peratherium giselense*.)

——— Eine Forest bed fauna aus der Schwäbischen Alb. Sitz.-Ber. Heidelberger Akad. Wiss., math.-naturw. Kl., Jahre. 1936, pt. 2, pp. 1–29, figs. 15. 1936.

HEPTNER, W. Notizen über die Gerbillidae (Mammalia, Rodentia). VII. Über die Formen und geographische Verbreitung der Gattung Brachiones Thos. Archiv. Mus. Zool. Univ. Moscou, vol. 1, pp. 3–11. 1934. (New: *Brachiones przewalskii callichrous*.)

——— Über die geographischen Rassen von Scirtopoda telum Licht. (Mammalia, Dipodidae). Sbornik Trudov Gosudarstvennogo Zoologicheskogo Muzeia (Archiv. Mus. Zool. Univ., Moscou), no. 2, pp. 17–22, fig. 1. 1935. (In Russian with German summary.)

HESSE, CURTIS J. Lower Pliocene vertebrate fossils from the Ogallala formation (Lavern zone) of Beaver County, Oklahoma. Carnegie Inst. Washington (Contrib. Palaeont.), publ. 476, pp. 47–71, figs. 10. October 30, 1936. (New: *Calippus martini*.)

HETT, G. V. Big game in Chosen. Field, London, vol. 167, no. 4336, pp. 226–227, illus. February 1, 1936.

HILL, JOHN ERIC, and T. DONALD CARTER. New insectivores, Elephantulus and Crocidura, from Angola, Africa. Amer. Mus. Novitates no. 937, pp. 4. July 13, 1937. (New: *Elephantulus intufi mossamedensis, Crocidura luimbalensis, C. cuanzensis, C. chitauensis*.)

HILZHEIMER, MAX. Über drei neue Formen des Rentieres. Zeitschr. f. Säugetierkunde, vol. 11, no. 1, pp. 154–158. March 13, 1936. (New: *Rangifer tarandus silvicola, R. t. transuralensis, R. t. dichotomus*.)

——— Der Bär aus dem Grubenloch (*Ursus arctos nemoralis* Degerböl). Zeitschrift f. Säugetierkunde, vol. 11, pp. 279–307, tables, pls. 9–14. March 13, 1936.

——— Der Vielfrass (*Gulo gulo* L.) aus dem Grubenloch. Zeitschr. f. Säugetierkunde, vol. 11, pp. 308–315, pls. 14–16. March 13, 1936.

——— Die übrigen Grossäugetiere. Zeitschrift f. Säugetierkunde, vol. 11, pp. 316–317. March 13, 1936.

——— Das geologische Alter der Bären- und Vielfrassreste. Zeitschrift f. Säugetierkunde, vol. 11, pp. 317–319. March 13, 1936.

HO, HSI J. Study of some mammals from Szechuan. Contr. Biol. Lab. Sci. Soc. China, vol. 11, no. 5, pp. 123–164. 1935.

HONIGMANN, HANS. Studies on nutrition of mammals. Part 1. Proc. Zool. Soc. London for 1936, pt. 2, pp. 517–530. July, 1936.

HOPWOOD, A. TINDELL. The former distribution of caballine and zebrine horses in Europe and Asia. Proc. Zool. Soc. London for 1936, pt. 4, pp. 897–912, figs. 2, pls. 2. January, 1937. (New: *Equus cautleyi*.)

HOSLEY, N. W. (Chairman), ET AL. Forest wildlife census methods applicable to New England conditions. Jour. Forest., vol. 34, no. 5, pp. 467–471. May, 1936.

HOWARD, E. B. The antiquity of man in America. Sci. Monthly, vol. 43, no. 4, pp. 367–371, figs. 3. October, 1936.

HOWELL, A. BRAZIER. The musculature of the antebrachium and manus in the platypus. Amer. Jour. Anat., vol. 59, no. 3, pp. 425–432, figs. 2. September 15, 1936.

——— The phylogenetic arrangement of the muscular system. Anat. Record, vol. 66, no. 3, pp. 295–316. October, 1936.

——— Phylogeny of the distal musculature of the pectoral appendage. Jour. Morph., vol. 60, no. 1, pp. 287–315. December 5, 1936.

HOWELL, ARTHUR H. Descriptions of three new red squirrels (Tamiasciurus) from North America. Proc. Biol. Soc. Washington, vol. 49, pp. 133–136. August 22, 1936. (New: *Tamiasciurus hudsonicus preblei*, *T. h. columbiensis*, *T. h. kenaiensis*.)

HUXLEY, JULIAN S. The growth of the infant chimpanzee born in the Society's Gardens, and a comparison with that of a chimpanzee born in Florida. Proc. Zool. Soc. London for 1936, pt. 2, pp. 587–589. July, 1936.

INGEBRIGTSEN, OLAF. En kapital norsk hjort. Bergens Mus. Arbok, 1935, no. 5, pp. 7, figs. 2. 1936.

JAHN, GUNNAR, JOHAN HJORT, and HARALD B. PAULSEN. International whaling statistics. VII. Edited by the Committee for Whaling Statistics appointed by the Norwegian Government. Norske Hvalråds Statistiske Publikasjoner, Oslo, pp. 54. 1936.

JEAREY, B. F. Wart-hogs and blue wildbeeste at large in their native haunts in the Transvaal: Strange beasts photographed together at a drinking pool. Illus. London News, vol. 189, no. 5082, p. 445, fig. September 12, 1936.

JEX-BLAKE, G. J. Notes on poisoning fruit bats (*Epimorphus wahlbergei*). Jour. East Africa and Uganda Nat. Hist. Soc., nos. 42–43, pp. 179–182. July, 1932.

JOHNSON, CARL M. A natural infection of Trypanosoma hippicum Darling in the vampire bat *Desmodus rotundus murinus* Wagner. Amer. Jour. Tropical Medicine, vol. 16, no. 1, pp. 59–62. January, 1936.

JOHNSON, F. WALKER. The status of the name "Valentine" in Tertiary geology and paleontology. Amer. Jour. Sci., ser. 5, vol. 31, no. 186, pp. 467–475. June, 1936. (Lists fossil mammals.)

KALABUCHOV, N. I., and W. M. RODIONOV. Hemoglobin content and number of erythrocytes in the blood of forest mice of the plains and of the mountains, belonging to the same subspecies (Apodemus sylvaticus ciscaucasicus Ogn.) and the alteration of these indicators when the habitat changes to a different altitude. Bull. Soc. Nat. Moscou, n.s., vol. 45, sect. biol., no. 1, pp. 22–35, figs. 4. 1936. (In Russian, with English summary.)

KATZ, DAVID, and ROSA KATZ. Some problems concerning the feeding behaviour of monkeys. Proc. Zool. Soc. London for 1936, pt. 2, pp. 579–582. July, 1936.

KELLOGG, CHAS. E. Polygamous mating of foxes. Wildlife Research and Management Leaflet BS-66, Bur. Biol. Surv., U. S. Dept. Agric., pp. 4. October, 1936.

——— Results from breeding rabbits that are suckling young. U. S. Dept. Agric., Washington, circular no. 410, pp. 8. October, 1936.

——— Relative weights of young rabbits and does during the suckling period. Wildlife Research and Management Leaflet BS-65, Bur. Biol. Surv., U. S. Dept. Agric., pp. 5. October, 1936.

KIES, C. H. M. H., ET AL. Nature protection in the Netherlands Indies. Spec. Publ. Amer. Comm. Internat. Wild Life Protection, no. 8, pp. 1–73, map. 1936.

KITCHING, G. C. The manatee of St. Helena. Nature, London, vol. 138, no. 3479 pp. 33–34. July 4, 1936.

KLUMOV, S. A new form of white whale. Biulleten' rybnogo Khoziaistvo SSSR (Sea Fishery Economics in USSR), Moscou, no. 7, pp. 26–28, figs. 2. 1935. (In Russian. New: *Delphinapterus freimani*.)

KOEPCKE, H. W. Ein zweiter Fund von *Mesoplodon bidens* (Sow.) an der deutschen Ostseeküste. Zool. Anz., vol. 113, nos. 5–6, pp. 157–158. February 1, 1936.

KOLESNIK, N. N. The origin and the geographical distribution of cattle. Bull. Acad. Sci. URSS. cl. sci. math. et nat., ser. biol., Moscou, nos. 2–3, pp. 375–414, figs. 28. 1936. (In Russian, with English summary.)

KOLLER, P. C. Chromosome behaviour in the male ferret and mole during anoestrus. Proc. Roy. Soc. London, ser. B., no. 822, vol. 121, pp. 192–206, figs. 1–11, pls. 3–4. November 2, 1936.

KORMOS, TH. Gedanken über die vorglazialen Wühlmäuse Ungarns. Folia Zool. et Hydrobiol., Riga, vol. 8, no. 1, pp. 1–10. August 30, 1935.

KRANZ, WALTER, FRITZ BERCKHEMER, and HEINRICH WÄGELE. Die "Seelberg"-Ablagerungen in Cannstatt, ihre geologischen Verhältnisse, Fossilfunde und Naturdenkmale. Jahreshefte Ver. Vaterl. Naturk., Württemberg, Stuttgart, Jahrgang 86, pp. 95–126, figs. 5. (1930) 1931.

LAMBERTON, C. Sur un nouveau genre de lémuriens fossiles Malgaches; Le *Prohapalemur* (*P. gallienii*). Bull. Mus. Nat. d'Hist. Nat., Paris, ser. 2, vol. 8, no. 5, pp. 367–369, figs. 2. October, 1936. (New: *Prohapalemur* for *Hapalemur gallienii* Standing.)

——— Nouveaux lémuriens fossiles du groupe des Propithèques et de l'intérêt de leur découverte. Bull. Mus. Nat. d'Hist. Nat., Paris, ser. 2, vol. 8, no. 5, pp. 370–373, fig. 1. October, 1936. (New: *Propithecus verreauxioides*, *Neopropithecus*, *N. globiceps*, *N. platyfrons*.)

LANG, W. D. Guide to the exhibition galleries of geology and palaeontology. Brit. Mus. (Nat. Hist.), London, 2d ed., pp. vii + 74, figs. 15. 1936. (Mammals, pp. 3–17.)

LAURENT, PAUL. Sur la présence au Maroc du Rat noir (*Rattus rattus* Linné *ater* Millais), ou, une addition à "Los Mamíferos de Marruecos" de Angel Cabrera. Bull. Soc. Hist. Nat. Afrique du Nord, vol. 27, no. 5, pp. 165–172. 1936.

LAURIE, ALEC H. The stock of Antarctic blue whales. Nature, London, vol. 138, no. 3479, p. 33. July 4, 1936.

LEAKEY, L. S. B. Die Menschenreste von Kanam und Kanjera, Kenya-Kolonie. Anthrop. Anzeiger, Stuttgart, vol. 10, nos. 2–3, pp. 238–243. 1933. (Associated fossil mammals.)

LEDWARD, C. N. The game sanctuaries of Natal. Publ. Natal Prov. Admin., Pietermaritzburg, pp. 32, 1 map, illus. 1936.

LEECH, PAUL NICHOLAS. The nomenclature of estrus-producing compounds. Jour. Amer. Med. Assoc., vol. 107, no. 15, pp. 1221–1223. October 10, 1936.

LLOYD, HOYES. The late Norman Criddle's record of the snowshoe rabbit (*Lepus americanus*) at Aweme, Manitoba. Canadian Field-Nat., vol. 50, no. 8, pp. 129–130. November, 1936.

LOGUINOFF, W. W. Nouvelles notions concernant la biologie du sanglier du Caucase (Sus scrofa attila Thomas). Bull. Soc. Nat. Moscou, n.s., vol. 45, sect. biol., no. 1, pp. 10–21. 1936. (In Russian with French summary.)

LOHRL, HANS. Beitrag zur Säugetierfauna des Federseegebiets. (Mit einem Erstnachweis für Württemberg.) Jahreshefte Ver. Vaterl. Naturk. Württemberg, Stuttgart, Jahrg. 90 (Veröffentl. Staatl. Stelle f. Naturschutz beim Württ. Landesamt f. Denkmalpflege), pp. 103–104. (1934) 1935.

LÖNNBERG, EINAR. The structure of the tail of the muskox. Vidensk. Meddel. Dansk Naturhist. For. København, vol. 99, pp. 29–31, fig. 1. July 15, 1935.

——— Några ord om halvspäckhuggaren, *Pseudorca crassidens* Owen. Fauna och Flora, Upsala, Häft 2, pp. 87–92, fig. 1. 1936.

——— Ännu en arktisk vikare, *Phoca hispida hispida*, funnen vid vår västkust. Fauna och Flora, Upsala, no. 5, p. 235. 1936.

LOPES, ALBERTO PEÃO. Fauna Moçambicana—Desdentados. (Edentata). Moçambique Documentário Trimestral, Lourenço Marques, no. 4, pp. 91–103, pls. 3, figs. 6. 1935. (Photographs showing manner of carrying young of pangolin and entrance to nest of aardvark.)

MacCurdy, George Grant. Prehistoric man in Palestine. Proc. Amer. Philos. Soc., vol. 76, no. 4, pp. 523–541, pls. 16. 1936.

Malyshef, V. The quantitative account of mammals by their tracks. Bull. Far Eastern Branch Acad. Sci. USSR, Vladivostock, no. 16, pp. 177–179. 1936. (In Russian.)

Marinelli, Wilhelm. Kranium und Visceralskelett. Allgemeine Probleme. Handbuch der vergleichenden Anatomie, Berlin and Wien, vol. 4, pp. 207–232, figs. 194–202. 1936.

Marshall, F. H. A. Sexual periodicity and the causes which determine it. Philos. Trans. Roy. Soc. London, ser. B., no. 539, vol. 226, pp. 423–456. December 8, 1936.

Martino, V., and E. Martino. Preliminary note on four new rodents from Korab Mountains. Ann. & Mag. Nat. Hist., London, ser. 10, vol. 19, no. 113, pp. 514–518. May, 1937. (New: *Dolomys grebenščikovi korabensis, Arvicola terrestris korabensis, Pitymys musteri, Sylvaemus sylvaticus stankovici*.)

Matsumoto, Hikoshichiro. Upper Miocene vertebrates from Kumanodô, Natori District, Province of Rikuzen. Zool. Mag., Japan, vol. 48, nos. 8–10, pp. 475–480. October, 1936. (In Japanese.)

Matthews, L. Harrison. The pelage and ear pinna of a newly born common seal (*Phoca vitulina* L.). Proc. Zool. Soc. London for 1936, pt. 1, pp. 315–316, fig. 1, pl. 1. April, 1936.

Matthey, Robert. Le problème des hétérochromosomes chez les mammifères. Archiv. Biol., Liege, vol. 47, fasc. 3, pp. 319–383, figs. 9, pls. 10–14. 1936.

Mertens, Rob. Der Hund aus dem Senckenberg-Moor, ein Begleiter des Ur's. Natur und Volk, Frankfurt a.M., vol. 66, no. 10, pp. 506–510, figs. 4. October 1, 1936.

Miller, Gerrit S., Jr. A new flying squirrel from West Virginia. Proc. Biol. Soc. Washington, vol. 49, pp. 143–144. August 22, 1936. (New: *Glaucomys sabrinus fuscus*.)

———— The status of Delphinus bairdii Dall. Proc. Biol. Soc. Washington, vol. 49, pp. 145–146. August 22, 1936.

Milroy, A. J. W. The preservation of wild life in India. Jour. Bombay Nat. Hist. Soc., vol. 37, no. 1, Appendix, pp. 97–111. April, 1934.

Mirando-Ribeiro, Alipio de. On some foetal and post-foetal characters of mammals and birds: concerning scales, hairs, and feathers. Proc. Zool. Soc. London for 1935, pp. 741–772, pls. 5–9. January, 1936.

Mohr, Erna. Biologische Beobachtungen an Solenodon paradoxus Brandt in Gefangenschaft. 1. Zool. Anz., vol. 113, nos. 7–8, pp. 177–188, figs. 17. February 15, 1936.

Mohr, Erna. Säugetiere in der Landschaft Thy (Jütland). Schrift. Naturw. Ver. Schleswig-Holstein, vol. 21, no. 3, pp. 427–439, figs. 6. 1936.

Most, K., and G. H. Brückner. Über Voraussetzungen und den derzeitigen Stand der Nasenleitungen von Hunden. Zentralblt. f. Kleintierkunde u. Peltzierkunde "Kleintier und Peltztier", Jahrg. XII, no. 5, Zeitschr. f. Hundeforschung, Leipzig, n. F., vol. 1, pp. 9–30, figs. 18. August, 1936.

Murie, Adolph. Following fox trails. Univ. Michigan, Mus. Zool., Misc. Publ. no. 32, pp. 45, figs. 7, pls. 6. August 7, 1936.

Nassimovitch, A. A. Sur quelques régularités de la propagation hivernale des ongulés dans les montagnes du Caucase Occidental. Bull. Soc. Nat. Moscou, n.s., vol. vol. 45, sect. biol., no. 1, pp. 3–9. 1936. (In Russian with French summary.)

Naumov, N. P. On some particularities of stationary distribution of mouse-like rodents in southern Ukraine. Zool. Jour. (Vormals "Revue Zool. Russe"), Moscou, vol. 15, no. 4, pp. 674–696. 1936.

NAUMOV, N. P. Multiplication and mortality in the common vole (Microtus arvalis Pall.). Abstracts Works Zool. Inst. Moscou Univ., no. 3, 1936, pp. 144–170, figs. 5. 1936. (In Russian with English summary.)

NEUGEBAUER, KAZIMIERZ. L'influence de la capsule ovarienne sur la fecondite de la rat blanche. Roczniki Prac Naukowych Zrzezenia Asytentów Uniwersytetu Józefa Pilsudskiego W. Warzawie, vol. 1, no. 8, pp. 167–183, figs. 2. 1936.

NEUHAUSER, GABRIELE. Diagnoses neuer kleinasiatischer Mäuse. Zeitschr. f. Säugetierkunde, vol. 11, no. 1, pp. 159–160. March 13, 1936. (New: *Meriones blackleri intraponticus, Pitymys majori fingeri, Microtus (Chionomys) nivalis olympius, Microtus (Chionomys) gud lasistanius, Microtus (Sumeriomys) guntheri shevketi.*)

NEUVILLE, HENRI. Sur le mimétisme sexuel de l'Hyaena crocuta. Mammalia, Paris, vol. 1, no. 2, pp. 49–58, fig. 1. December, 1936.

NEVIANA, ANTONIO. Di un Globicefalo trovato morto nel mare presso Ladispoli (Roma). Mem. Pont. Accad. Sci. Nouvi Lincei, Roma, ser. 2, vol. 16, pp. 273–308, figs. 3. 1932.

O'CONNOR, JACK. Old Felis concolor. An article on the habits and the hunting of this large American cat. Field & Stream, vol. 41, no. 4, pp. 36–37; 64–65, illus. August, 1936.

OLSON, ORANGE A. Elk management. Utah Juniper, Logan, Utah, vol. 7, pp. 10–15, illus. 1936.

O'MAHONY, EUGENE. Norwegian mice of the genera Mus and Apodemus. Meddelelser fra det Zool. Mus., Oslo, no. 44, pp. 137–139. October 31, 1934.

ORLOV, J. A. Fundort der Hipparionfauna am Irtysch in der Stadt Pawlodar (W. Sibirien). Trav. Inst. Paléozool. Acad. Sci. URSS, vol. 5, pp. 155–169, figs. 7. 1936.

OSGOOD, WILFRED H. New and imperfectly known mammals from Africa. Zool. Series, Field Mus. Nat. Hist., vol. 20, no. 21, pp. 217–256. December 28, 1936. (New: *Sylvisorex suncoides, S. sorella phaeopus, Crocidura zimmeri, C. baileyi, C. hildegardeae phaeura, Tatera minuscula, Tachyoryctes splendens canicaudus, T. cheesemani gallarum, Dendromus insignis abyssinicus, D. lunaris, D. oreas, Lophuromys flavopunctatus simensis, L. brevicaudus, L. aquilus chrysopus, Muriculus imberbis chilaloensis, Hylomyscus aeta laticeps, Arvicanthis abyssinicus fluvicinctus, Hybomys univittatus badius, and Dasymys incomptus griseifrons.*)

OSSAT, G. DE ANGELIS D'. Mammiferi fossili recentemente rinvenuti nel Lazio. Atti Pontificia Accad. Sci. Nouvi Lincei, vol. 86, no. 2, pp. 91–94, figs. 2. 1933.

OWL, GREY. A plea for the beaver. Jour. Soc. Preservation of Fauna of Empire, Hertford, n.s., pt. 26, pp. 17–23. September, 1935.

PATANÈ, G. MAUGERI. Su alcune ossa fossili di mammiferi quaternari incontrada Batteria presso Augusta (Sicilia). Atti Accad. Gioenia Sci. Nat. Catania, ser. 5, vol. 19, no. 1, pp. 1–12, pl. 1. (1932) 1933.

PATTERSON, BRYAN. The internal structure of the ear in some Notoungulates. Geol. Ser. Field Mus. Nat. Hist., vol. 6, no. 15, pp. 199–227, figs. 44–54. October 31, 1936.

PATTERSON, ROBERT C. Notes on Neotoma pennsylvanica with special reference to the genital organization. West Virginia Univ. Bull., ser. 33, no. 15 (Proc. W. Virginia Acad. Sci., vol. 6), pp. 38–42. March, 1933.

——— Habits of Neotoma pennsylvanica. West Virginia Univ. Bull., ser. 34, no. 15 (Proc. W. Virginia Acad. Sci., vol. 7), pp. 32–35. March, 1934.

——— Some notes on Myotis lucifugus. Proc. W. Virginia Acad. Sci., (W. Va. Univ. Bull., ser. 35, no. 15), vol. 8, no. 1, pp. 52–54. March 15, 1935.

PEACOCK, A. D. The false killer whales stranded in the Tay Estuary. Scottish Nat., no. 220, pp. 93–104, illus. July–August, 1936. (*Pseudorca crassidens.*)

PEI, W. C. Peking man. Nature, London, vol. 138, no. 3503, p. 1056. December 19, 1936.

——— On the mammalian remains from locality 3 at Choukoutien. Palaeontologia Sinica, series C, vol. 7, no. 5, pp. 120, figs. 59, pls. 6. 1936. (New: *Crocidura wongi*, *Microtus complicidens*.)

PHILLIPS, PAUL. The distribution of rodents in overgrazed and normal grasslands of central Oklahoma. Ecology, vol. 17, no. 4, pp. 673–679. October, 1936.

PIRES DE LIMA, J. A. Hypertrophie des dents incisives chez un *Mus decumanus albinus*. Bull. Soc. Portugaise Sci. Nat. Lisbonne, vol. 11, no. 12, pp. 155–158, pl. 1. 1932.

PLYATER-PLOKHOTSKY, K. Materials on the study of succession of mouse-like rodents of southern districts of the Far Eastern Region. Bull. Far Eastern Branch Acad. Sci. USSR, Vladivostok, no. 16, pp. 175–177. 1936. (In Russian with English summary.)

——— On the biology and ecology of *Apodemus agrarius mantschuricus* Thom. and dinamics of its reproduction. Bull. Far Eastern Branch Acad. Sci. USSR, Vladivostok, no. 19, pp. 93–110, figs. 10. 1936.

POCOCK, R. I. The foxes of British India. Jour. Bombay Nat. Hist. Soc., vol. 39, no. 1, pp. 36–57, figs. 3. December 1, 1936.

——— The mongooses of British India, including Ceylon and Burma. Jour. Bombay Nat. Hist. Soc., vol. 39, no. 2, pp. 211–245, figs. 2. April 15, 1937. (New: *Herpestes fuscus rubidior*.)

PONTIER, GEORGES. Étude du bulbe de la défense du *Dinotherium giganteum* Kaup. Ann. Soc. Geol. du Nord, Lille, vol. 58, pp. 118–125, figs. 2. 1933.

——— Étude sur la dentition de l'*Elephas* (*Archidiscodon*) *imperator* Leidy (1858). Ann. Soc. Géol. du Nord, Lille, vol. 58, pp. 127–134, figs. 2. 1933.

PRICE, PAUL H., and DANA WELLS. Mastodon (*Mammut americanum*) remains in river gravels at Point Marion, Pa. West Virginia Univ. Bull., ser. 33, no. 15 (Proc. W. Virginia Acad. Sci., vol. 6), pp. 81–84, pl. 1. March, 1933.

PYCRAFT, W. P. Some new aspects of evolution. Trans. Norfolk and Norwich Nat. Soc., vol. 14, pt. 1, pp. 1–30, pls. 4. (1935) 1936.

——— The white-tailed gnu. Illus. London News, vol. 189, no. 5076, p. 210, illus. August 1, 1936.

——— Hands and feet: Servants of the brain. Illus. London News, vol. 189, no. 5087, p. 666, figs. 2. October 17, 1936.

——— How did the hedgehogs get their spines? Illus. London News, vol. 189, no. 5089, p. 786, illus. October 31, 1936.

——— The musk-ox: An arctic ruminant. Illus. London News, vol. 189, no. 5090, p. 829, illus. November 7, 1936.

——— Four-horned sheep: Immigrants into Europe from the East. Illus. London News, vol. 189, no. 5095, p. 1078, figs. 4. December 12, 1936.

QUENSTEDT, W., and A. QUENSTEDT. Hominidae fossiles. Fossilium Catalogus I: Animalia. Pars 74, pp. 456. W. Junk: Verlag für Naturwissenschaften, 's-Gravenhage. April 15, 1936.

RACEY, KENNETH, and IAN MCTAGGART COWAN. Mammals of the Alta Lake region of southwestern British Columbia. Report Prov. Mus. Nat. Hist for 1935, Victoria, B. C., pp. H15–H29, pls. 5. 1936.

RAJ, S. SUNDARA. Clicking sounds made by muntjac. Jour. Bombay Nat. Hist. Soc., vol. 37, no. 2, p. 486. August 15, 1934.

RALL, J. M. Neues über Verbreitung von *Diplomesodon pulchellum* Licht. zwischen den Flüssen Wolga und Ural (Mammalia, Insectivora). Comptes Rendus (Doklady) Acad. Sci. URSS, Moscou, vol. 3, no. 8, pp. 377–378. 1935.

RALL, G. M. Character of the propagation of certain rodents as a factor of their number in nature. Comptes Rendus (Doklady) Acad. Sci. URSS, Moscou, vol. 4 (13), no. 2 (106), pp. 93–96, figs. 4. 1936.

RAVEN, H. C. Notes on the anatomy of the viscera of the giant panda (*Ailuropoda melanoleuca*). Amer. Mus. Novitates no. 877, pp. 23, figs. August 8, 1936.

——— Hunting gorillas in West Africa. Sci. Monthly, vol. 43, no. 4, pp. 313–334, illus. October, 1936.

——— Gorillas, men and sleeping sickness. Chapter XIII of Gregory, William King, "In quest of gorillas." Sci. Monthly, vol. 43, no. 6, pp. 522–540, illus. December, 1936.

REESE, A. M. The fauna of West Virginia. West Virginia Univ. Bull., ser. 34, no. 15, (Proc. W. Virginia Acad. Sci., vol. 7), pp. 39–53. March, 1934.

REIDER, NORMAN. The Primate colon. Proc. Zool. Soc. London for 1936, pt. 2, pp. 433–453, pls. 10. July, 1936.

REIN, RICHARD. Aus dem "Eiszeitlichen Wildgehege." Naturforscher, vol. 13, no. 8, pp. 277–280, pls. 16, figs. 4. November, 1936.

RENNER, F. G. Conditions influencing erosion on the Boise River watershed. U. S. Dept. Agric., Tech. Bull. 528, pp. 22, figs. 14. October, 1936. (Rodents, principally *Thomomys fuscus* and *Citellus idahoensis*, considered responsible for accelerated erosion.)

RENSHAW, GRAHAM. The quagga. Jour. Soc. Preservation of Fauna of Empire, Hertford, n.s., pt. 26, pp. 23–29. September, 1935.

RIBEIRO, ALÍPIO DE MIRANDA. Notes cétologiques. Bull. Soc. Portugaise Sci. Nat., Lisbonne, vol. 11, no. 11, pp. 145–153, figs. 4. December, 1931.

RICHARD, JULES. Documents sur les Cétacés et Pinnipèdes provenant des Campagnes du Prince Albert I^{er} de Monaco. Résultat des Campagnes Scientifiques accomplies sur son yacht par Albert I^{er} Prince souverain de Monaco, publiés sous sa direction avec le concours de M. Jules Richard, fasc. 94, pp. 71, pls. 8. 1936.

RICHTER, RUD. Zur Eröffnung der Lebensgruppe Frankfurter Urlandschaft. Natur und Volk, Frankfurt a.M., vol. 66, no. 10, pp. 499–506, figs. 5. October 1, 1936.

ROBINSON, A. E. The camel in antiquity. Sudan Notes and Records, vol. 19, pt. 1, pp. 47–69. 1936. (In recorded history, domesticated cattle date back to about 3000 B. C., horses to about 2000 B. C., and camels to about 1200 B. C.)

RODE, P. Les durées de gestation des mammifères sauvages d'après C. E. Brown. Comparaison avec les résultats de G. Jennison. Mammalia, Paris, vol. 1, pp. 26–28. September, 1936.

——— Note sur de daman du Fouta-Djalon (*Procavia ruficeps oweni* Thos.). Bull. Mus. Nat. d'Hist. Nat., Paris, ser 2, vol. 8, no. 6, pp. 478–482, figs. 3. November, 1936.

——— Sur quelques caractères différentiels de la tête osseuse des cercopithèques et des cercoèbes. Mammalia, Paris, vol. 1, no. 2, pp. 59–64, figs. 2, tables 2, pls. 2. December, 1936.

——— Le baguage des chauves-souris (Analyse du travail de Donald R. Griffin). Mammalia, Paris, vol. 1, no. 2, pp. 7–72. December, 1936.

RODIONOV, Z. Effect of surrounding conditions on the burrows of rodents. Bull. Soc. Nat. Moscou, sect. biol., vol. 45, no. 4, pp. 256–262. 1936.

ROE, F. G. The Red River hunt. Trans. Roy. Soc. Canada, sect. 2, ser. 3, vol. 29, pp. 171–218. May, 1935. (Extermination of bison on plains of Canada.)

ROTMANS, WILLIAM. Satan, the friendly chipmunk. Nature Mag., vol. 28, no. 4, pp. 223–225, illus. November, 1936. (*Tamias striatus*.)

ROWLANDS, I. W. Reproduction of the bank vole (*Evotomys glareolus* Schreber). II. Seasonal changes in the reproductive organs of the male. Philos. Trans. Roy. Soc. London, ser. B, no. 531, vol. 226, pp. 99–120, pls. 12–15. March 18, 1936.

RUMJAHCEV, B. F. Origin of the domestic horse. Bull. Acad. Sci. URSS. cl. sci. math. et nat., ser. biol., Moscou, nos. 2–3, pp. 415–448, figs. 21. 1936.

RUSCONI, CARLOS. Sobre camélidos sud-americanos. La Semana Médica, vol. 40, no. 2043, pp. 856–857. March 9, 1933.

——— La supuesta afinidad de Argyrolagus con los Typotheria. Bol. Acad. Nac. Cienc. Cordoba, vol. 33, entr. 3a, pp. 173–182, figs. 12. 1936.

——— Distribución de los vertebrados fósiles del piso ensenadense. Bol. Acad. Nac. Cienc. Córdoba, vol. 33, pp. 183–215. 1936.

RUSSELL, LORIS S. New and interesting mammalian fossils from western Canada. Trans. Roy. Soc. Canada, Ottawa, ser. 3, vol. 30, sect. 4 (geol. sci.), pp. 75–80, pl. 1. (May, 1936.) January 5, 1937. (New: *Cimolomys major*.)

SÄLZLE, KARL. Untersuchungen über Farbsehvermögen von Opossum, Rötelmäusen und Eichhörnchen. Zeitschr. f. Säugetierkunde, vol. 11, no. 1, pp. 106–148, pls. 47–56. March 13, 1936.

SAMUEL, EDWARD. Strange mammals from Australia. Discovery, London, vol. 17, no. 202, pp. 303–307, figs. 6. October, 1936. (Good photographs of platypus, flying foxes, echidna, and flying opossum.)

SANBORN, COLIN CAMPBELL. Records and measurements of Neotropical bats. Zool. Ser. Field Mus. Nat. Hist., vol. 20, no. 13, pp. 93–106. August 15, 1936.

SAWAYA, PAULO. Alguns aspectos da biologia dos "Saguis" *Hapale jacchus* (L.). Bol. Biol., S. Paulo, n.s., vol. 2, no. 4, pp. 11, figs. 3. 1936.

——— Sobre a placenta bidiscoidal de *Hapale jacchus* (L.). Rev. Biol. e Hyg., S. Paulo, vol. 7, no. 1, pp. 53–58, figs. 2. August, 1936.

——— Bipartição total do osso parietal em dois *Cebus*; bipartição parcial num craneo humano. Ann. Faculdade Med. Univ. S. Paulo, vol. 10, fasc. 2, pp. 209–217, figs. 6–9. 1934.

——— Dente conoide supranumerario no "foramen incisivum" do paladar de uma *Lutra paranaensis* Rengg. Ann. Faculdade Med. Univ. S. Paulo, vol. 10, fasc. 2, pp. 203–209, figs. 2–5. 1934.

——— Participação do Vomer á constituição do paladar duro em um Cebus macrocephalus Spix. Ann. Faculdade Med. Univ. S. Paulo, vol. 10, fasc. 2, pp. 198–203, fig. 1. 1934.

SCHAEFER, HELMUT. Studien an mitteleuropäischen Kleinsäugern, mit besonderer Berücksichtigung der Rassenbildung. Archiv. Naturgesch., Leipzig, Abt. B., n.F., vol. 4, no. 4, pp. 390–535, map, figs. 20. 1935. (New: *Microtus* (*nivalis* ?) *marhanreini*.)

——— "In den Karpaten gibt es keine Murmeltiere mehr"—eine Entgegnung. Zool. Anz., vol. 113, nos. 11–12, p. 334. March 15, 1936.

SCHEPE, A. K. Zur Biologie von *Alactaga jaculus* Pall. als Schädling auf den Pflanzungen von Scorzonera tau-saghyz Lipsh. et Bosse in der Ukraine. Zbirnik Prats' Zoologichnogo Muzeiu Vseukraïns'ka Akademiia Nauk Institut Zoologiï tai Biologiï (Trav. Mus. Zool. Acad. Sci. Urkaine, Inst. Zool. et Biol.), no. 13, pp. 166–167. 1934. (In Ukranian with German summary.)

SCHERPING. Das Jagdwesen in Deutchland. Zeitschr. f. Weltforstwirtschaft, Neudamm u. Berlin, vol. 3, nos. 11–12, pp. 856–867, figs. 10. (Sonderheft Deutschland). August–September, 1936. (Game management in Germany.)

SCHERTZ, E. Unser Ur und seine Aufstellung in der Lebensgruppe. Natur und Volk, Frankfurt a.M., vol. 66, no. 10, pp. 510–515, figs. 4. October 1, 1936. (*Bos primigenius* Bojanus.)

SCHERTZ, E. Der Geschlechts-Unterschied an Metapodien von Bison. Senckenbergiana, Frankfurt a.M., vol. 18, nos. 5–6, pp. 357–381, figs. 3. December 31, 1936.

SCHIRMEISEN, KARL. Tierreste aus Kulturschichten des Nikolsburger Gebiets. Nachtrag. Verhandl. Naturforsch. Ver. Brünn., vol. 67, pp. 134–137. (1935) 1936.

SCHOONMAKER, WALTER J. How heavy is your game? Field & Stream, vol. 41, no. 4, p. 72. August, 1936. (Weights of various mammals.)

SCHREUDER, A. Trogontherium cuvieri Fischer von Püspökfürdő, nebst einer Bemerkung über die Castoriden von China. Ann. Hist.-Nat. Mus. Nat. Hungarici, Budapest, vol. 29, pp. 21–28, figs. 3. 1935. (In German.)

——— Hypolagus from the Tegelen clay; with a note on Recent Nesolagus. Archives Néerlandaises de Zool., Leiden, vol. 2, nos. 2–3, pp. 225–239, figs. 6, pl. 2. December 21, 1936.

SCHULTZ, ADOLPH H. Characters common to higher primates and characters specific for man. Quart. Review Biol., vol. 11, no. 3, September, 1936, pp. 259–283, figs 9; no. 4, December, 1936, pp. 425–455, figs. 10–21.

SCHULTZ, C. BERTRAND, and EDGAR B. HOWARD. The fauna of Burnet Cave, Guadalupe Mountains, New Mexico. Proc. Acad. Nat. Sci. Philadelphia, vol. 87, pp. 273–298, pls. 11–16. 1936.

SCHWARZ, ERNST. A propos du "Lemur macaco" Linnaeus. Mammalia, Paris, vol. 1 no. 1, pp. 24–25. September, 1936.

——— Die fossilen antilopen von Oldway. Wissenschaftliche Ergebnisse der Oldoway-Expedition 1913, herausgeben von Prof. Dr. H. Reck, Berlin, n.F., no. 4, pp.7–90, figs. 4, pls. 3. 1937. (New: *Taurotragus oryx pachyceros, Gazella gazella praecursor, Phenacotragus, P. recki, Damaliscus angusticornis.*)

SCOTT, WILLIAM BERRYMAN. The laws of mammalian evolution. Sci. Monthly, vol. 43, pp. 421–429. November, 1936.

SEREBRENNIKOV, M. Contributions à la classification et à l'oecologie des Rongeurs du Gouvernement de Samara. Annuaire Mus. Zool., Leningrad, vol. 27, no. 4, pp. 337–346, pls. 24–25. 1927. (New: *Evotomys glareolus ognevi.*)

SHAW, J. C.: Evidence concerning a large fossil hyrax. Jour. Dental Res., vol. 16, no. 1, pp. 37–40, fig. 1. February, 1937. (New: *Procavia transvaalensis.*)

SHIKAMA, TOKIO. Note on *Parastegodon akashiensis takai* from the Akasi district. Proc. Imp. Acad., Tokyo, vol. 12, no. 1, pp. 22–24, figs. 4. 1936.

SHITKOV, B. Zur Terminologie der Katzenarten. Bull. Soc. Nat. Moscou, ser. biol., vol. 45, no. 3, pp. 225–232. 1936.

——— Über den Elch in USSR. Zeitschr. f. Säugetierkunde, vol. 11, no. 1, pp. 16–19, fig. 1. March 13, 1936.

SHORTRIDGE, G. C. Field notes (Hitherto unpublished) on Western Australian mammals south of the Tropic of Capricorn (exclusive of Marsupialia and Monotremata), and records of specimens collected during the Balston Expeditions (November 1904 to June 1907). Proc. Zool. Soc. London for 1936, pt. 3, pp. 743–749, fig. 1. September, 1936.

SICKENBERG, O. Über den Wert von Wirbeltierresten für die Stratigraphie des Tertiärs. Mitteilungen Geol. Gesell. Wien, vol. 28, pp. 137–150. 1935.

SIEBER, RUDOLF. Remarques sur les Anthracotherium de l'Oligocène Français. Bull. Soc. Hist. Nat. de Toulouse, vol. 70, fasc. 1, pp. 351–361. December 30, 1936.

SIMPSON, G. G. Post-Mesozoic Marsupialia. Fossilium Catalogus. 1: Animalia, pt. 47. W. Junk: Berlin, pp. 87. September 10, 1930.

——— Studies of the earliest mammalian dentitions. Dental Cosmos, Philadelphia, vol. 78, no. 9, pp. 940–953, figs. 10. September, 1936.

——— Carsioptychus, new name for Plagioptychus Matthew, nec Matheron. Amer. Jour. Sci., ser. 5, vol. 32, no. 189, p. 234. September, 1936.

SIVERTSEN, ERLING. Über die chemische Zusammensetzung von Robbenmilch. Nyt. Mag. f. Naturvidensk., Oslo, vol. 75, pp. 183–185. 1936.

SKINNER, MILTON P. The Roosevelt elk of the Olympic Peninsula. Murrelet, Seattle, Wash., vol. 17, nos. 2–3, pp. 31–35, illus. November 14, 1936.

SODY, H. J. V. A new flying squirrel from Sumatra. Natuurk. Tijdschr. Nederland.-Indie, vol. 96, no. 2, pp. 146–147. 1936. (New: *Petaurista bartelsi*.)

SOUEF, A. S. LE. How Australian fauna fares. Jour. Soc. Preservation of Fauna of Empire, Hertford, n.s. part 16, pp. 45–48. April, 1932.

SPÄRCK, R. Bidrag til dansk zoogeografi og faunistik. 4: Om egernets udbredelse og hyppighed i Danmark. Vidensk. Meddel. Dansk Naturhist. For. Köbenhavn, vol. 99, pp. 267–281, map. March 30, 1936. (*Sciurus vulgaris*.)

STARTSEVA, F. V., and G. A. GLUMOV. Contributions to the ecology and biology of the rodents of the Troitsk district, form. Ural Prov. 4. Influence of farming on the spread of rodents of steppe stations. Izvestiia Biologicheskogo Nauchno-Issledovatel'skogo Instituta pri Permakom Gosudarstvennom Universitete (Bull. Inst. recherches biol. Univ. Perm). vol. 10, no. 3, pp. 125–143. 1936. (In Russian with English summary.)

STEHLÍK, ALOIS. Elephas primigenius aus dem Höhlen-Diluvium der Stránská skála bei Brno. Práce Moravské Přírodov. Společn. (Acta Soc. Sci. Nat. Moravicae) Brno, vol. 5, no. 1, pp. 1–23, figs. 7. 1928–1929. (With German summary.)

ST. LEGER, JANE. Dr. Karl Jordan's expedition to South-west Africa and Angola: Mammals. Novitates Zool., vol. 40, no. 1, pp. 75–81. August 25, 1936.

——— Mammals collected by the Lake Rudolf Rift Valley Expedition, 1934, with postscript by R. W. Hayman. Ann. & Mag. Nat. Hist., London, ser. 10, vol. 19, no. 113, pp. 524–531. May, 1937. (New: *Heliosciurus multicolor dysoni*, *Rhinopoma cystops macinnesi*.)

STOCK, CHESTER. A peccary skull from the Barstow Miocene, California. Proc. Nat. Acad. Washington, vol. 23, no. 7, pp. 398–404, fig. 1, pl. 1. July, 1937. (New: *Dyseohyus*, *D. fricki*.)

STONER, DAYTON. Wildlife casualties on the highways. Wilson Bull., vol. 48, no. 4, pp. 276–283. December, 1936.

STRAUS, WILLIAM L., JR., and A. BRAZIER HOWELL. The spinal accessory nerve and its musculature. Quart. Review Biol., vol. 11, no. 4, pp. 387–405. December, 1936.

TANAKA, RYÔ. On a form of *Eothenomys melanogaster* (Milne-Edwards) from Taiwan, Japan. Trans. Nat. Hist. Soc. Formosa, vol. 26, nos. 155–156, pp. 305–309, figs. 3. September, 1936. (In Japanese with English summary.)

——— On the insectivorous fauna in Taiwan, Japan. Trans. Nat. Hist. Soc. Formosa, vol. 26, nos. 155–156, pp. 310–313. September, 1936. (In Japanese with English summary.)

TATE, G. H. H. Some Muridae of the Indo-Australian Region. Bull. Amer. Mus. Nat. Hist., vol. 72, art. 6, pp. 501–728, figs. 21. December 31, 1936.

TAYLOR, WALTER P. The prong-horned antelope in the southwest. Proc. N. Amer. Wildlife Conference, Febr. 3–7, 1936, Senate Comm. Print, 74th Congr., 2d Sess., Washington, pp. 652–655. 1936.

TEILHARD, DE CHARDIN, P., and M. TRASSAERT. The proboscideans of southweastern Shansi. Palaeontologia Sinica, ser. C, vol. 13, no. 1, pp. 84, figs. 6, pls. 13. 1937. (New: *Pentalophodon cuneatus*, *Mastodon intermedius*, *Stegodon licenti*.)

TETLEY, J. H. Route of migrating parasites in ruminants. Nature, London, vol. 138, no. 3497, p. 802. November 7, 1936.

TINDALE, N. B., F. J. FENNER, and F. J. HALL. Mammal bone beds of probable Pleistocene age, Rocky River, Kangaroo Island. Trans. and Proc. Roy. Soc. S. Australia, Adelaide, vol. 59, pp. 103–106, figs. 3. December 23, 1935.

TIRALA, L. G. Wie sieht der fliegende Feind des Hasen aus? Biol. Zentralbl., Leipzig, vol. 55, nos. 9–10, pp. 526–528. 1935.

TOBIEN, HEINZ. Über die pleistozänen und postpleistozänen Prolagusformen Korsikas und Sardiniens. Ber. Naturf. Ges. Freiburg i. Br., vol. 34, no. 2, pp. 253–344, maps 2, figs. 6. 1935.

TOKUDA, MITOSI, and TADAO KANO. A bat and a new shrew from Kôtô-Shô (Botel-Tobago). Annotations Zool. Japonenses, vol. 15, no. 4, pp. 427–432, figs. 2, tables. December 1, 1936. (*New: Crocidura tadae.*)

TOMILIN, A. G. Der Pottwal des Kamtschatka-Meeres. Zool. Zhurnal, vol. 15, no. 3, pp. 483–519, figs. 2. November 13, 1936. (In Russian with German summary.)

TOOGOOD, C. G. Number of cubs in a tigress litter. Jour. Bombay Nat. Hist. Soc., vol. 39, no. 1, pp. 158–159. December 1, 1936.

TROUGHTON, ELLIS LE G. A redescription of Solomys ("Mus") salamonis Ramsay. Proc. Linnean Soc. New South Wales, vol. 61, pts. 3–4, pp. 128–130. September 15, 1936.

TROUGHTON, E. LE G., and A. S. LE SOUEF. Two new tree kangaroos from Papua, with notes on allied forms. Australian Zool., Sydney, vol. 8, pt. 3, pp. 193–197. June 29, 1936. (New: *Dendrolagus spadix, D. deltae.*)

———— A new tree-kangaroo from southeastern Papua. Records Australian Museum, vol. 19, no. 6, pp. 388–390. October 7, 1936. (New: *Dendrolagus dorianus profugus.*)

TURKEWITSCH, B. G. Das knöcherne innere Ohr des Hausesels (Equus asinus L.). Zeitschr. f. Säugetierkunde, vol. 11, no. 1, pp. 1–15, pls. 17–18. March 13, 1936.

TUROV, S. S. Une variation de coloration de Prometheomys schaposchnikovi (Mammalia, Muridae). Sbornik Trudov Gosudarstvennogo Zoologicheskogo Museia (Archiv. Mus. Zool. Univ. Moscou), no. 1, pp. 43–44, figs. 2. 1934. (In Russian with French summary.)

TUTEIN-NOLTHENIUS, A. C. Exploitation of wild life (Ceylon). Jour. Bombay Nat. Hist. Soc., vol. 37, no. 1, pp. 219–220. April, 1934.

VÄLIKANGAS, ILMARI. Ein neuer Fund des Gartenschläfers, *Eliomys quercinus* (L.) in Finnland. Notulae Zool. in: Ann. Zool. Soc.-Bot. Fennicae, Vanamo, vol. 2, no. 2, pp. 20–24, map. 1935.

VORHIES, CHARLES T. Rodents and conservation. Control projects provide easy but dubious way to spend money. Nature Mag., vol. 28, no. 6, pp. 363–365, 379, illus. December, 1936.

WATTS, W. W. Prof. W. J. Sollas, F. R. S. (Obit. note). Nature, London, vol. 138, no. 3501, pp. 959–960. December 5, 1936.

WEIDENREICH, F. *Sinanthropus pekinensis*—A distinct primitive hominid. Proc. Joint Meeting Anthrop. Soc. Tokyo, and Japanese Soc. Ethnol., 1st session, Tokyo, pp. 13–37, figs. 13. 1936.

WEDEMEYER, K. O. Zahl der Schwanzringe bei Apodemus sylvaticus L. und flavicollis Melchior als Artmerkmal. Zool. Anz., vol. 113, nos. 7–8, pp. 205–207. February 15, 1936.

WETTSTEIN, OTTO. Ein Beitrag zur Säugetierfauna Niederösterreichs. Verhandl. Zool.-Bot. Ges. Wien, vol. 83, nos. 3–4, pp. 210–216. December 31, 1933.

WILLIAMS, J. White bison in South Coimbatore. Jour. Bombay Nat. Hist. Soc., vol. 39, no. 1, pp. 166–168. December 1, 1936.

WOOD, ALBERT ELMER. Fossil rodents from the Siwalik beds of India. Amer. Jour. Sci., ser. 5, vol. 34, no. 199, pp. 64–76, figs. 14. July, 1937. (New: *Kanisamys, K. indicus, K. sivalensis, Sayimys, S. perplexus.*)

WOOD, FAE DONAT. Trypanosoma neotomae, sp. nov., in the dusky-footed wood rat

and the wood rat flea. Univ. Calif. Pub. Zool., vol. 41, no. 11, pp. 133–144, pl. 9. September 29, 1936.

WOODWARD, A. SMITH. William Johnson Sollas. Professor of Geology at Oxford, 30th May, 1849–20th October, 1936. Man, London, vol. 36, nos. 270–292, pp. 212–213. December, 1936.

——— (Review of) Henry Fairfield Osborn: Proboscidea, a monograph of the discovery, evolution, migration and extinction of the mastodonts and elephants of the world, vol. 1. Nature, London, vol. 138, no. 3499, pp. 860–862. November 21, 1936.

YERKES, ROBERT M. A chimpanzee family. Jour. Genetic Psych., vol. 48, no. 2, pp. 362–370. June, 1936.

YERKES, ROBERT M., and ADA W. YERKES. Nature and conditions of avoidance(fear) response in chimpanzee. Jour. Comp. Pschy., vol. 21, no. 1, pp. 53–66. February, 1936.

YERKES, ROBERT M. and JAMES H. ELDER. Oestrus, receptivity, and mating in chimpanzee. Comp. Psychol. Monog., vol. 13, no. 5, pp. 39. October, 1936.

COMMENT AND NEWS

The Society, through its Committee on Marine Mammals, and the affiliated Council for the Conservation of Whales and Other Marine Mammals, has been active at every opportunity for many years in an endeavor to assure the perpetuation in reasonable numbers of the larger Cetacea. Because of the necessity of international regulations and the difficulty of securing these for any details involving freedom of the high seas, progress has, at times, been extremely slow, and a period of years has been necessary for attainment of the objective.

At a conference held at Berlin in April, 1930, under the auspices of the Economic Committee of the League of Nations, at which Dr. Remington Kellogg was the representative of the United States, real progress was made in the drafting of a Convention for the Regulation of Whaling. This Convention, which was concluded at Geneva on September 24, 1931, by the representatives of 26 countries, was signed on behalf of the United States March 31, 1932, and became operative January 16, 1935, the delay being attributable to the difficulties incident to ratification by many nations.

More recent developments, however, are even more gratifying. On June 8, 1937, there was concluded in London, an International Conference on the Whaling Industry, the United States being represented by Herschel V. Johnson, First Secretary of the American Embassy in London, and Remington Kellogg. Here it was agreed, subject to ratification, that there should be an annual closed season of nine months for pelagic whaling, and of six months for shore stations, that the killing of baleen whales be prohibited between 40 degrees south latitude and 20 or 35 degrees north latitude (varying with the longitude), that right whales and gray whales shall be protected at all times, and full protection shall be given blue whales of less than 70, fin whales of less than 55, and humpbacks and sperm whales of less than 35 feet in length. This agreement was signed by the representatives of nine governments, including Great Britain, Norway, and Germany, and the United States Senate assented to its ratification on August 5, 1937.

Because of the fact that so little is known regarding the migrations of whales and many other details of their life histories, it is realized that more adequate regulations cannot be determined immediately. Accordingly it is highly desirable that frequent international conferences be held with a view to amending the regulations. There are indications that this course will be followed by the governments most concerned.

The Society is indebted to Dr. William J. Hamilton, Jr., for the preparation of the index of the current volume.

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